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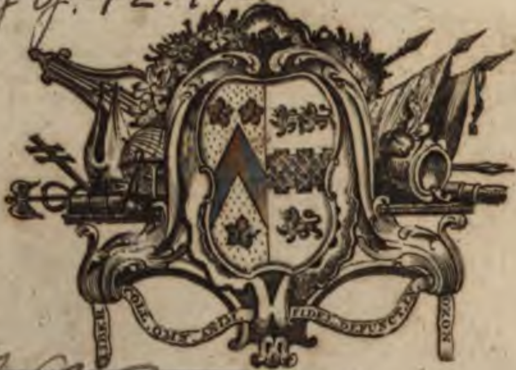

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A

GENERAL SYSTEM

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CHEMICAL KNOWLEDGE,

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A
GENERAL SYSTEM
OF
CHEMICAL KNOWLEDGE;
AND ITS
APPLICATION
TO THE
PHENOMENA OF NATURE AND ART.

BY A. F. FOURCROY,
Of the National Institute of France, Counsellor of State, Professor of Chemistry at various Public Establishments, Member of many Academies, &c.

IN ELEVEN VOLUMES.

TOGETHER WITH A SET OF SYNOPTIC TABLES, IN LARGE FOLIO.

TRANSLATED FROM THE ORIGINAL FRENCH,

BY WILLIAM NICHOLSON.

COLL. OMN. ANIM. OXON.

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TENTH VOLUME.

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ART.

A SYSTEM OF CHEMICAL KNOWLEDGE.

CONTINUATION OF THE EIGHTH SECTION.

Concerning the Animal Subſtances.

Article XX.

Of the Gaſtric and Pancreatic Juices.

1. THE gaſtric juice, which always exiſts more or leſs abundantly in the ſtomach of animals, and moiſtens its ſides, is ſecreted in glands which are very perceptible in birds, but are difficult to be ſeen, and appear to be but very little abundant in the human ſpecies and the mammalia. This juice is likewiſe very difficult to be obtained pure, becauſe it is ſo frequently mixed with ſaliva, with mucus, with bile, with the reſiduum of the aliments, &c.

This is the reafon why many authors, without denying its exiftence, have at leaft doubted of its great influence in digeftion. Ancient chemical experiments had already been made upon the gaftric juice, by Wepfer, Brunner, Viridet, Floyer, Raft, as we fee from the fhort notice publifhed by Haller, in his Phyfiology. But thefe experiments were very little adapted to afford any light refpecting the nature of this humour; they could only throw obfcurity over its properties. Befides, it had always appeared difficult to procure a fufficient quantity of it to fubject it to an exact analyfis, and it is only in modern times that we have begun to find means of obtaining it pure.

2. Since 1744, Reaumur, one of the French phyficians and naturalifts, who beft perceived the neceffity of making experiments with accuracy and precifion upon the living animals, firft conceived and executed the project of examining the gaftric juice, and determining its effect in the digeftion of the aliments. He has well demonftrated that this function is not performed by preffure and trituration, but that it is principally owing to the action of this juice. Since him, Spallanzani refumed this inquiry nearly twenty years ago, and carried his experiments much farther than Reaumur had done, efpecially with regard to the proceffes for collecting the gaftric juice as pure as poffible, and fo as to be able to fubject it to fome chemical experiments. He efpecially recalled in fome meafure the

the attention of philofophers to this matter, and it was fince his inquiry that Citizens Scopoli, Monch, Brugnatelli, Carminati, Jurine, Goffe, Toggia, Vauquelin, and Macquart, undertook different refearches, with the aid of which we have at prefent, if not a complete knowledge, at leaft fome more pofitive notions concerning the fubject than were formerly poffeffed.

3. We have no accurate knowledge refpecting the true fource of the gaftric juice, and there does not appear to be any glandular organ deftined for its fecretion, at leaft not in the mammalia. We cannot therefore obtain this juice very pure from any refervoir in which we can be certain of finding a fufficient quantity of it; it is not poffible to obtain it fufficiently pure, as Spallanzani has done, unlefs by caufing birds to fwallow fponges, having a ftring attached to them which iffues out of the beak, and drawing them out again after having fuffered them to remain fome hours in the ftomachs of thefe animals whilft fafting. That of the human fpecies, which has been procured by means of emetics, that which has been taken from the ftomachs of calves or fheep immediately after they have been killed, having been made to faft for fome time before, cannot be confidered as pure gaftric juice, becaufe it is mixed either with the other liquors expreffed at the fame time, or with fome remains of the aliments. We are therefore by no means as yet entitled

to confider the analyfis of the gaftric juice as fufficient for animal philofophy: what has hitherto been done can only be confidered as preliminary effays proper for giving an idea of its importance.

4. For a want of a feries of experiments upon the nature of the pure gaftric juice, we may be affifted, in commencing the ftudy of its properties, by feveral other experiments, which without having a direct relation with the true chemical proceffes, may at leaft fupply their place. I place under this head the obfervations made upon the aliments difcharged, by natural or artificial vomiting, at different periods of the digeftion, the numerous inveftigations of Reaumur and Spallanzani upon the effects produced upon different aliments, by remaining inclofed in open tubes, in the midft of the ftomach, where they can only be penetrated and changed by the gaftric juice; the facts obferved by fome authors upon the gaftric juice, or at leaft upon a liquid of the ftomach which muft contain it, evacuated by the efforts of vomiting; the experiments made by feveral modern phyficians, as well upon different fubftances remaining immerfed in the gaftric juice of birds, and of fome of the mammalia, as upon the applications of this juice in feveral internal and external maladies. By combining the refult of thefe different obfervations or experimental attempts with the portion of real chemical refearches that have been commenced upon the

gaftric

gaftric juice by fome modern chemifts, we fhall at leaft find in them feveral points of the chemical hiftory of this fluid.

5. Several phyfiologifts affert that they have found the gaftric juice acid, either after it had been difcharged by natural vomiting, or after the effect of an emetic, or even in the ftomachs of animals opened for anatomical obfervations. In thefe cafes it has feveral times been found fufficiently four to redden turnfole and to effervefce with the alkaline carbonates. Some have even gone fo far as to affert that the fides of the ftomach were equally acid. Others have found the gaftric juice at the fame time bitter, acrid and acid in birds of prey; aqueous, turbid and faline in the ruminant animals. Citizen Goffe, of Geneva, obferved that his own gaftric juice had a well-marked acidity when he had eaten crude vegetables. Spallanzani believes that this character depends upon the nature of the aliments and does not belong to the gaftric juice properly fo called; for he affures us that he has never found it acid in the carnivorous, but on the contrary always fo in the frugivorous animals. The acidity found in the gaftric juice is owing, according to fome, to an acid analogous to that of the lemon, of forrel, or of vinegar; whilft Citizen Brugnatelli has believed it to be produced by the phofphoric acid, which Citizens Vauquelin and Macquart have actually difcovered in the gaftric juice of the calf, the bullock, and the fheep. To thefe firft notions

we

we muſt ſubjoin what other obſervers have had occaſion to remark upon aliments thrown up at different periods after their having been received into the ſtomach, which they have found more or leſs four, and the numerous facts of flatulencies and eructations, which frequently give riſe to a very ſtrong and diſagreeable ſenſation of acidity in the throat and mouth.

6. In the ſeries of experiments made by Spallanzani upon the effects produced in the aliments by the gaſtric juice with different animals, experiments confirming of thoſe of Reaumur, he has found that this juice is the principal agent in digeſtion, that it changes the aliments into a ſoft and hermogeneous paſte; that it ſoftens cartilages, tendons and even bones: that it diſſolves vegetable or animal ſubſtances without diſtinction, without appearing to have more attraction for the one than for the other, notwithſtanding the nature of the animals and their kind of food, that it is one of the moſt powerful antiſeptics, ſince it reſtores putrefied fleſh introduced into the ſtomach, and prevents the ſeptic alteration of ſubſtances, otherwiſe very ſuſceptible of putrefaction, which are left immerſed in it. It is a ſolvent of ſingular activity, without acrimony, which unites readily with all the alimentary ſubſtances. The reſults which I here indicate, were obtained by the profeſſor of Pavia by cauſing birds and mammalia to ſwallow tubes of wood, open and provided with wire-work at

their

their ends, in order to contain the fragments of different ſubſtances, and ſuffer the gaſtric juice to penetrate eaſily into them.

7. One of the moſt remarkable qualities of the gaſtric juice, conſiſting in its antiſeptic quality, muſt alſo have moſt ſtruck the attention of philoſophers, and they have performed many numerous experiments upon it. After having extracted this juice from crows and ſheep, either by cauſing them to ſwallow metallic balls, or by opening their ſtomachs and taking it immediately from them; after having found that the moſt putreſcible animal matters, ſurrounded with this liquid, remained in it for ſeveral days without alteration, though the ſame ſubſtances, kept out of it, either alone or ſteeped in water, eaſily corrupted; Citizens Carminati, Jurine and Toggia applied this juice to the ſurface of fetid ulcers, and found it to prove very effectual in checking the putrid diſpoſition of theſe ſurfaces. This experiment has been repeated by ſeveral phyſicians ſince the firſt trials, and moſt of them have confirmed the general reſult here indicated. However it does not appear to have been ſufficiently ſatisfactory to the faculty, as its uſe has not become general during ten years ſince theſe experiments have been commenced, and the employment of the gaſtric juice has not been ſubſtituted inſtead of the external antiſeptics which were known and applied long before.

8. We

8. We may conclude from the combination of thefe different orders of facts, that the general nature of the gaftric juice is yet far from being known, according to the phyfiological facts ; that this juice appears to differ in the different animals and to be fimilar in all of them only by its foftening and folvent property ; that its fenfible properties appear to receive varied modifications from the aliments received into the ftomach, efpecially when thefe have been ufed for fome time, that though it is fometimes or even often acid, it is not to its peculiar nature that this character belongs, but to the admixtures of the alimentary refidues, and that there is no particular acid which ought to be called gaftric acid, as fome chemifts have believed, or at leaft that its exiftence has not been proved ; that what moft effentially characterizes this living animal liquid is its two fold property of diffolving, or at leaft of melting or foftening all the matters charged with alimentary particles, and of retarding or entirely ftopping their putrid decompofition, and even of correcting this decompofition when already well marked in alimentary fubftances.

9. Perhaps the idea of the energy of this folvent power has been carried too far when it has been faid that the hardeft filiceous ftones, even rock-cryftal itfelf were blunted at their angles, deprived of their polifh, and confequently diffolved by the action of the gaftric juice. It it is much more eafy to conceive the fingular obferva-

obſervation of Hunter, who has remarked this ſolvent power acting upon the ſides of the ſtomach itſelf, ſoftening, macerating, diſſolving them, when there are no more aliments in this viſcus upon which its powers can be exerted, and this effect taking place even ſome hours after death. Perhaps it is in this circumſtance that the ſenſation of hunger conſiſts, which, when it has continued for ſome time, becomes a painful ſenſation, like that produced by an acrid or ſlight corroſive. Though it is difficult to raiſe doubts reſpecting experiments repeated by ſo many able and accurate philoſophers, I have to oppoſe to them the experiments of Citizens Macquart and Vauquelin, of which I myſelf have been a witneſs, and which were made in my laboratory; fleſh immerſed in the gaſtric juice of the bullock, the calf and the ſheep, putrefied as eaſily and as quickly as portions of the ſame fleſh that had remained in contact with the air, or were macerated in water.

10. The firſt phyſiologiſts who employed chemical means and inductions for aſcertaining the nature of the gaſtric juice obtained only uncertain reſults, and moſt of them of little utility. According to Reaumur, Viridet, Deidier, Peyer, Brunner, Langriſh, and Collins, this juice conſidered as ſalivary, is entirely evaporable, mucous inſipid or ſlightly ſaline, neither acid nor alkaline. Raſt of Lyons, in experiments which he performed at the ſuggeſ-

tion

tion of Haller, found the gaſtric juice in the mule and the ſheep, when fatting, to be mucous viſcous, frothy and liable to become fetid, not coagulable by the ſulphuric and nitric acids, to turn the colour of violets green, to froth by agitation, to be entirely volatilized by fire, unalterable by alcohol, and to depoſit filaments by the action of a fixed alkali. Haller concluded from theſe experiments, which were made at his ſolicitation, that the gaſtric juice was a compound of water and of a mucilage, and that it approached to the alkaline nature. For the reſt, he conſidered it as a mixture of ſaliva, of the mucus of the ſtomach, of the juice of the œſophagus, of the pancreatic humour, and of a kind of mucus ſecreted by glands. It is evident that the immortal anatomiſt of Helvetia had not more accurate ideas of the nature of the gaſtric juice than he had of moſt of the animal liquids. It is true, he wrote this part of his great work in 1764, at a period when the organic chemiſtry was ſtill involved in the moſt profound darkneſs.

11. Mr. Scopoli has examined with a little more care and accuracy the gaſtric juice of the crow, which Spallanzani had ſent him, requeſting that he might ſubject it to chemical analyſis. Mr. Scopoli perceived in it at firſt a diſagreeable odour: lime and pot-aſh developed ammonia from it. It turned the ſyrup of violets green; it produced no efferveſcence with the powerful acids. Expoſed to a ſlow fire, it yielded about $\frac{1}{72}$

 of

of a deliquefcent fetid, not effervefcent refiduum. He extracted from it by diftillation an ammoniacal water, and concrete carbonate of ammonia; it condenfed in the retort into an obfcure extractiform mafs, not effervefcent, of an empyreumatic fmell, of a faline, bitter, naufeous tafte, exhaling ammonia by the contact of a fixed alkali. This juice precipitated the nitrate into muriate of filver. He concluded from thefe experiments, that the gaftric juice of the crow was a compound of water, of faponaceous and gelatinous animal matter, of muriate of ammonia and of phofphate of lime, which Mr. Scopoli calls *animal earth*. It is evident that this analyfis, inferted in the work of Spallanzani upon digeftion has no direct relation with the refearches of this phyfician, and that they have afforded no light refpecting the great folvent force or the antifeptic property of the gaftric juice.

12. Since the experiments of Mr. Scopoli upon the gaftric juice of crows, I know only Citizens Macquart and Vauquelin, who have occupied themfelves with fome chemical refearches refpecting this animal liquor. They procured from the flaughter-houfes gaftric juice of fheep, bullocks and calves. It is natural to fuppofe that in operating upon the liquor of the ftomach of ruminant animals, they muft have obtained refults different from thofe of Mr. Scopoli. Accordingly they found in it phofphates and free phofphoric acid of which

which the Italian chemiſt makes no mention. They alſo ſeparated a ſmall quantity of albumen from it by the acids, beſides which they obtained a mucous or gelatinous animal ſubſtance. None of the gaſtric juices which they analyſed preſented to them that antiſeptic property of which ſo much has been ſaid; all three, on the contrary, corrupted in ſome days time, and becoming turbid, exhaled a very fetid ſmell. It may be believed that, if the antiſeptic property of the gaſtric juice be proved in the living ſtomach by the experiments of Spallanzani, which in fact ſhow that animal matters do not contract a bad ſmell in this viſcus, and that thoſe which are introduced into it with certain ſigns of putrefaction are corrected by the very act of digeſtion, yet this antiſeptic property at leaſt loſes much of its energy out of the ſtomach, and that the gaſtric juice then putrefies with more or leſs facility. The fetid ſmell which Mr. Scopoli has deſcribed in the gaſtric juice of the crow, which Spallanzani had given him to analyſe, ſufficiently indicates this property of ſepticity.

13. I have joined the pancreatic with the gaſtric juice, as well becauſe the ſource and the reſervoir of theſe two liquids are contigious with each other, as becauſe the hiſtory of the pancreatic juice contains nothing real, nothing ſufficiently known or ſufficiently important to deſerve to be treated of ſeparately. It is known that the pancreas, a gland of conſider-

able

able magnitude, situated in the circumvolutions of the duodenum, has an excretory duct of the diameter of a writing pen, described and delineated in 1642, by Wirsungus, formed by the union of a great number of other small ducts, and which proceeds increasing in magnitude, from the left to the right, till it opens into the duodenum, after having united with the ductus choledochus within the membranes of the intestines themselves. This duct is almost always found empty in dissections. Haller has never been able to find pancreatic juice in it with the human subject, and Rast could never succeed, in the veterinary school of Lyons, at the solicitation of Haller, to find a sufficient quantity of it and separate it sufficiently from the bile, in the largest animals, for it to be subjected to experiments.

14. The desire of suporting the opinion of their perceptor, F. Sylvius, suggested to Reg. de Graaf and Schuyl the means of procuring this juice, by introducing into the pancreatic duct of dogs a phial, which they tied to it, and in which the juice collected. Though most of the animals perished under the operation, which in fact is a very difficult one, and affords no hope of success, they succeeded in it sufficiently well to ascertain that this liquor was of a whitish colour, of a slightly saline taste, and very similar to the saliva, as the structure of the pancreas and of its duct resembles that of the salivary glands and ducts.

Collins

Collins has ſince found the ſame analogy between the pancreatic and the ſalivary calculi. Graaf collected to the amount of 32 grammes of this juice in eight hours in a dog, and Schuyl more than 90 grammes in two hours in the ſame animal. The firſt of theſe anatomiſts, calculating according to the comparative weight of the body, has eſtimated that in man 288 grammes (nearly nine ouces) of pancreatic juice may be effuſed in 24 hours; and Haller finds this calculation too low, even according to the compariſon of the ſalivary glands.

15. Graaf and Schuyl, at the end of the laſt century, aſſerted that the pancreatic juice, like the ſaliva, was acid; that it reddened the tincture of turnſole; that it coagulated milk, and that its taſte was manifeſtly ſour. It was in this manner that they ſupported the hypotheſis of Sylvius, who maintained that this acid juice made effervefcence with the bile, ſeparated the chyle from the excrements, and being carried with the blood into the heart, acted there by irritating and diſtending it by means of the ſame effervefcence. Dippel maintained the ſame idea concerning the pancreatic juice, and carried it ſo far as to pretend that the pancreas gave an acid and not an alkali in diſtillation. This hypotheſis of Sylvius did not maintain itſelf long: its abuſe was carried to that degree, that it was expected to indicate the cauſe of diſeaſes and the indication of the remedies. Drelincourt, Pechlin, Brunner, Bohn,

Bohn, Fred. Hoffmann, and Boerhaave the fucceffor of Sylvius, combated it with advantage; they maintained that the pancreatic juice was not acid, that it did not coagulate milk. Two witneffes of the too famous experiments of Graaf upon a failor who had fuddenly died, and in whom he faid he had found the pancreatic juice acid, afferted that this juice was infipid; Deider even fhowed that on the contrary it turned the fyrup of violets green, and as the principal hypothefis of Sylvius confifted in attributing the caufe of the motion of the heart, and the true vital principle to the pancreatic liquor, Brunner contributed much to overturn it by proving that dogs from which he had either cut out the pancreas, or deftroyed, or tied their pancreatic duct, lived even without any very fevere or very perceptible morbid confequences.

16. The comparifon and a certain analogy between the pancreatic juice, and the faliva have however been confidered as fufficiently exact affertions in the fchools, fince the fall of the hypothefis of Sylvius, and they are generally admitted, though no pofitive experiments have been made upon the nature of this juice. It is believed to be formed for diluting the the cyftic bile, diminifhing its acrimony and its power of acting upon the inteftines, favouring its mixture with the aliments, and thus retarding their defcent into the inteftinal canal. Hence, it is faid, exift the greater

degree

degree of hunger and the vomiting of bile with animals from which the pancreas has been taken out, and the ſize of this gland proportionate to the abundance and the acrimony of the bile. The pancreatic juice is alſo admitted to poſſeſs the property of diluting and diſſolving the alimentary maſs. Upon this principle phyſiologiſts explain the voracity of animals, in which this juice is poured out into the ſtomach or very near to this viſcus, the largeneſs of the pancreas in animals that do not drink, the dryneſs and conſtriction of the belly in ſubjects with whom the pancreatic duct is compreſſed, as in the dogs from which Brunner cut out the pancreas. For the reſt, a new and important analyſis which ſtill remains to be made, is that of this liquid hitherto ſo little known, and nevertheleſs ſo intereſting to be known for animal phyſiology and medicine.

ARTICLE XXI.

Of the Bile.

SECTION I.

Formation and Secretion of the Bile.

1. THE bile is one of the animal humours which require the moſt profound ſtudy, not only on account of its importance in the animal economy, the part which it acts in digeſtion, the extenſive and remarkable apparatus which nature has appropriated to its formation and its ſecretion, but likewiſe of the numerous alterations of which it is ſuſceptible, the knowledge of which is of ſo great importance to phyſicians. Neither is there any matter upon which more has been written; and nevertheleſs it was not till ſome years after the middle of the eighteenth century, that we began to acquire accurate notions reſpecting its nature and compoſition, as I ſhall ſoon make appear. But what ſubſtance amongſt all that the animal body preſents requires more to be well known? Continually prepared by a viſcus of conſiderable volume and weight, the extent of its ſecerning organs is alone ſufficient to ſhow that it is deſtined for uſes of a very high order in the

support of life. We find the liver in almost all animals, down to the insects and worms, in which indeed it presents a structure very different from that observed in the mammalia, the birds, and the fishes, by the numerous, insulated, and floating vascular filaments which constitute it in these two classes of animals. It constantly occupies a large space in their bodies, and it constitutes a well determined system of organs and functions destined to exert a great influence upon the animal machine.

2. The liver, a very large viscus in man and in the mammalia, placed in one of the sides of the abdominal cavity, of a deep red colour, which the ancients considered as an entirely sanguineous organ, destined for the formation of the blood, receives a large quantity of a particular blood different from that which exists in the other regions of the body, and is transmitted to it by a vascular system equally distinct from all the other apparatuses of vessels. It is from the surface of the intestines, from the epiploon, the mesentery and mesocolon, the spleen and the stomach, that the blood destined for the liver derives its origin: the veins, returning from all these regions, unite into a large arteriform vessel, or one that performs the function of an artery, which is called the vena port. The greatest anatomists and physiologists, Malpighi, Glisson, Bianchi, Fanton, Senac, who have long occupied themselves with researches concerning the structure of the

the liver and of the whole hepatic ſyſtem, have admitted a particular character in the blood deſtined for the ſcretion of the bile. After all the ridiculous opinions that have been advanced, from the times of antiquity down to the preſent age, it has been generally agreed that this viſcus is deſtined to give to the blood, which penetrates its texture in abundance, a quality particularly relative to the formation of the bile. It reſults from all the facts that have hitherto been collected upon this ſubject, that the blood of the vena port, being more black, and ſlower in its motion, appears to be impregnated with fatty humour, with vapour from the excrements, even with a bitter quality, and diſpoſed not only to the ſeparation of an oily matter, but alſo to that of a liquor more inclined than any other to alkaleſcence; and though Haller has juſtly obſerved that there was as yet no poſitive experiment for proving this particular character of the blood of the vena port, he has however not been able to diſavow that anatomical appearances and the combination of all the phyſiological circumſtances rendered this view of the particular nature of the hepatic blood almoſt as probable as experiment could do.

3. The vaſcular extremities of the vena port appear to terminate partly in the ramifications of the vena cava, partly in biliary pores, the union of which gives riſe to the hepatic duct. From this duct the bile flows in man, and in

efpecially in difeafes, from the confiftence of a thick oil, or a pitchy and glutinous matter, to a concrete ftate of more or lefs folidity.

Its denfity is in general, greater than that of water, though it is alfo fufceptible of feveral variations. Wifcher has found its weight compared with that of water as 102 to 100, or as 810 : 795. Lamure indicates the relation between thefe two liquids as 38 to 37. It has alfo been indicated as lighter than the milk and the blood. According to Silberling, who has written a particular differtation upon the fpecific weight of the animal humours, the weight of the bile is to that of the milk as 2004 to 2086 and to that of the blood as 395 to 406. Hamberger gives this laft proportion as 2006 : 2072; Jurin as 100 : 102. Mufchenbroeck indicates the proportion of the weight of the bile to that of water as 1,0246 : 1,0000. Bianchi Hartman, and Payen however fay that the bile is heavier than the blood. Thefe differences announce a remarkable variation, which depends upon a mutitude of circumftances relative to the health and ficknefs of the individual.

6. The colour of the bile is very frequently green or always mixed with this tinge : it is conftantly green in birds, quadrupeds, the oviparous animals, and the fifhes. It has been found blue in the rattle-fnake. It is of a greenifh yellow colour in moft of the mammalia, and in man. The yellow is fo effential to its nature, that it tinges with this caft both the veffels in which it

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is contained, and the vicinity of the gall-bladder through the pores of which it tranfpires, as alfo the parts below the epidermis when it is conveyed into and detained in the veffels fpread out under this integument; it acquires a deeper colour the longer it has remained in its receptacles. Its yellow colour always accompanies its thick ftate and its fluidity; its thinnefs is conftantly marked by the green colour: however, this laft colour is generally produced in the fœtus before the bitter tafte. For the reft, nothing appears to be more variable than the colour of the bile. Madder, taken internally, has been obferved to give a red caft to the bile at the fame time that it gave this colour to the bones. This liquid is fo intenfely bitter, that fix drops of bile communicate an intolerably bitter tafte to 33 grammes of pure water. This bitternefs is general in all kinds of bile; it is even combined with an harfhnefs, an acrid property, which goes as far as the virous nature in fome of the amphibia. When it is aqueous it is infipid; when it is acrid it is at the fame time thick, fince thefe ftates conftantly correfpond in the different circumftances.

7. Frefh bile diffufes a very particular faint fmell, which Ramfay has defcribed as aromatic, but which is fometimes fetid. I fhall foon fpeak of thecaufes and of the circumftances which fometimes producees in the bile a very marked fmell of mufk. It froths much by agitation. It is not eafy to determine the quantity of it which is

is formed in man during a given time. Some physiologists have occupied themselves with this subject: and by taking the mean term of their calculations, we may approach pretty near to the truth. Cujet. Tacconus collected 130 grammes (about 4 ounces) of bile at a single time; by a wound that penetrated into the gall-bladder. Bianchi has estimated that 65 grammes (about 2 ounces) flow in 24 hours from the gall-bladder. This quantity appears much too small to Haller, who estimates with Valcarenghi that nearly 780 grammes (24 ounces) of it are effused in 24 hours, and who thinks that of these 780 grammes 130 collect in the gall-bladder, where they are detained for some time, and 650 flow gradually into the intestine. Some anatomists however believe that the whole of the bile passes out of the liver into the gall-bladder, and that it does not flow into the duodenum, which is closed and folded together except during the time of digestion. It is also here to be remarked that in the vertical position of man, the bile does not flow out of the vesicle into the intestine except when the full stomach raises itself in such a manner as to place its bottom higher than the extremity of the ductus choledoctus, and that the horizontal situation upon the left side is the circumstance most favourable to this discharge.

8. The bile has been examined with more attention and has been sooner pretty well known than most of the other animal liquids, either because

becaufe the importance of this examination has been early perceived, or becaufe its analyfis, which in general is more eafy and fimple, gave to the firft men of learning who occupied themfelves with it pretty fatisfactory refults. Boerhaave and Bianchi have made it the fubject of feveral experiments, without however determining its nature with fufficient exactnefs. We are even aftonifhed that the very clear fighted eye of the celebrated profeffor of Leyden fhould have been fo much deceived, as to reprefent the bile as the moft putrefcible of the animal fluids; an error which has prevailed more than fixty years in medicine, and which has formed the bafe of a great number of hypothetical theories concerning difeafes and their treatment.

Verheyen has analyfed the bile much better than the preceding, and has only been furpaffed by the modern chemifts.

Fred. Hoffmann, Drelincourt, Hartmann, Barchufen, Wifcher and many other phyficians have given us ufeful facts refpecting the properties of this liquor. Schroeder has examined a confiderable number of mixtures of bile with different, efpecially animal, liquors. Mather has efpecially directed his attention to the animal mucilage of the bile, and believed that all its effects were efpecially owing to it.

Gaubius, in his chymical lectures, treated the analyfis of the bile much in detail, and a great number of his pupils have availed themfelves of his labours, the whole merit of which Haller, who

who quotes him often, has juſtly attributed to him.

Cadet, of the Academy of Sciences of Paris gave, in 1767, a good Memoir upon the bile; and he began to diffuſe more accurate ideas than thoſe which had been advanced before him reſpecting the ſaponaceous compoſition of this liquor, and the ſoda which is contained in it.

Poulletier de la Salle has publiſhed, in Madame Darconville's treatiſe on putrefaction, ſome intereſting experiments on the human bile.

Van Bochaute, Profeſſor at Louvain, wrote, in 1778, a Latin Diſſertation, containing important obſervations reſpecting the nature of this liquor, the oily matter, and the means of ſeparating all the materials which conſtitute it.

Laſtly, I have added ſeveral new facts reſpecting the analyſis of the bile, its oily ſubſtance, its alterations, its precipitation by different re-agents, the nature of the parenchyma of the bile, the ſecretion which it performs, as well as reſpecting the nature of the blood that flows into it. The reſults of all theſe labours arranged in the order which I have adopted for the expoſition of all the animal ſubſtances, will form the ſubject of the preſent article.

SECTION. III.

Section III.

Of the Chemical Properties of the Bile.

9. WHEN the bile is expoſed to a mild heat, it becomes thickened, and loſes the greater part of its weight, being reduced to one-eighth. The water which exhales from it diffuſes in the laboratory a faint, diſagreeable ſmell, which cannot be deſcribed, but which however is very diſtinguiſhable. We thus obtain a ſolid maſs, of a dark-brown colour, of a bitter and at the ſame time ſweetiſh taſte, which is ſoftened by the warmth of the hands, is ductile and pitchy, attracts the moiſture of the atmoſphere, diſſolves in water, leaving however a ſmall quantity of reſiduum, producing a ſlight efferveſcence with the acids, and acquiring, when kept for ſome time, a very perceptible ſmell of muſk or amber-greaſe: this is what is called the *ſapa*, or the *extract of the bile*. When this operation is performed in cloſe veſſels, and by the mere heat of the water-bath we obtain nearly ſeven-ninths of the weight of the bile of a very clear water, having a faint ſmell, which preſents nothing by the re-agents, unleſs the diſtillation be carried too far, or the bile be altered and corrupted. In the latter caſe, the aqueous product has frequently a pretty ſtrong ſmell

ſmell of muſk, and becomes turbid as it cools. The reſiduum of this diſtillation is extract of bile, as in the evaporation by open fire.

10. The inſpiſſated bile, or the extract of bile, when heated in a retort, is decompoſed with particular phenomena. When the fire is applied with caution and in a ſucceſſive manner, we firſt obtain water a little turbid, already of a fetid ſmell, precipitating the metallic ſalts, and almoſt always containing ſulphurated hidrogen. The bile afterwards ſwells conſiderably, increaſes in volume ſo as to fill almoſt the whole of the retort: the liquid which then paſſes is brown and very fetid; it contains carbonate and zoonate of ammonia. It is ſoon ſucceeded by an oil, at firſt thin and light, afterwards brown, thick, and empyreumatic, and of an intolerably fetid odour; at the ſame time that ſolid and cryſtallized carbonate of ammonia attaches itſelf to the ſides of the receiver, and there paſſes with rapidity and in abundance an elaſtic fluid, conſiſting of a mixture of carbonic acid gas, carbonated and ſulphurated hidrogen gas, frequently containing a ſmall quantity of oil in the ſtate of vapour. Amongſt theſe products it is obſerved, that the carbonate of ammonia does not amount to an eighth of the quantity which is obtained from the blood and the bones of animals; and this obſervation, which has eſcaped neither Verheyen nor Van Bochaute, has induced the latter to conclude that the bile is much leſs animalized than many other

other animal fubftances. There remains a very black, fpongy and fwelled coal, which burns eafily, from which Verheyen extracted fixed alkali, of the nature of which he was then ignorant, though he obtained it without incinerating this coal. This coal, after it has been expofed for fome days' to the air, prefents an efflorefcence of carbonate of foda. When it is well incinerated, it preferves a deep grey colour; there is feparated from it, with the aid of cold water, almoft half its weight of carbonate of foda, a little muriate of foda, phofphate of the fame bafe, phofphate of lime, and fome traces of iron. It is to be obferved, that if the retort has not been fufficiently heated in this operation, and if the bile has not been well reduced to coal, we have in the retort, inftead of a real coal, a black mafs refembling a bitumen, luminous and brittle, liquifiable by a ftrong heat, and which keeps very dry with the contact of the air.

11. The bile has always been confidered amongft phyficians, and efpecially fince Boerhaave, as one of the moft putrefcible animal liquids that are known; and it is confidered in this light becaufe, in fact, when kept in air, the temperature of which exceeds 15 degrees, it pretty quickly diffufes a difagreeable fmell, which foon announces a rapid putrefaction. However, Van Bochaute has given in his Differtation a contradictory experiment; and he has rather ftrongly combated the opinion of Boerhaave

Boerhaave reſpecting this putreſcible property of the bile. Human bile, he ſays, which was very thick, and of a dark green colour, mixed with a ſmall quantity of diſtilled water, and placed in a bottle half filled and well cloſed, kept for ſix intire months without exhibiting any ſigns even of incipient putreſcence; but on the contrary it diffuſed a manifeſtly vinous odour; which led him to think that it contained a ſaccharine matter in quantity ſufficient even for carrying the maſs into the vinous fermentation. But without denying the truth of this experiment, it is too well known to anatomiſts, to phyſicians, and even to fullers, who employ large quantities of bullock's bile or gall under the name of bitter, for taking ſpots out of cloth, that this liquor putrefies readily in the hot air for it to be poſſible to doubt of this property. We may only conclude, that though the putrefactive movement ſhows itſelf eaſily in this liquor, it advances but very ſlowly and with much difficulty towards its total decompoſition, on account even of the bitter property of this animal liquid, and the ſaponaceous nature of a part of its ſubſtance, of which I am about to ſpeak. When bile that has already become a little fetid is boiled for ſome inſtants, it aſſumes a fine green colour, and afterwards keeps for a long time without alteration.

12. Thick and ropy bile, poured into water, firſt paſſes through it and collects at the bottom of this liquid as being more heavy, on account of

of its tenacity. At the end of fome hours, the mixture of the two liquors is gradually effected. By agitation this mixture is effected immediately; the bile lofes its vifcidity, or ropy property; it partakes of the liquidity of water; it gives it a yellow colour, verging upon brown, or a mere golden yellow when the water is very abundant. When the bile is green, this caft does not remain in the water, or it difappears very quickly in the air, and paffes to the yellow colour. When we heat bile diluted with its own weight of water, we obferve no coagulation of the albuminous matter which it contains, becaufe it is held in perfect folution by the alkaline foap of which I fhall foon fpeak. Van Bochaute, who well knew this phenomenon, faw and announced that white of egg, beat up and added to the bile, does not coagulate in this liquor, even though boiling, and that its faponaceous quality, by diffolving and retaining it united with the water, prevented its concretion by the fire. The bile diluted with a fmall quantity of water turns the fyrup of violets green, and alfo paper tinged with mallows, renders violet that which has been coloured with cucurma. It is difficult to conceive how Boerhaave, Haller, Marherr, and feveral other phyfiologifts, have miftaken and denied the alkaline nature of the bile, which fhows itfelf, as we fhall fee by a great number of indubitable facts.

13. All

13. All the acids poured upon the bile decompofe it, and produce an abundant precipitation in it. If we put into the bile only a few drops of an acid, the precipitate forms at firft an opaque cloud which affumes the appearance of froth, in which many fmall bubbles of gas are perceived. In all thefe decompofitions, the precipitate acquires a green colour, efpecially by the muriatic acid. A part of this precipitate remains fufpended and even diffolved in the fluid when it is much agitated, or when thefe matters are left for fome time in contact. The liquor, when filtrated, leaves upon the filtre a coagulated albuminous animal matter: when evaporated, this liquor depofits flakes of a deep green colour, fimilar to pitch, which foften and appear tenacious and gluey under the fingers, and when thrown upon ignited coals, fwell and inflame readily, burning after the manner of a refin. After the feparation of this refiniform matter, the liquor affords by evaporation a falt with foda for its bafe, differing according to the fpecies of acid that has been employed. It is in this manner that the chemifts, for forty years paft, have proved the prefence of foda in the bile, and its combination with an oil in the faponaceous ftate.

14. The chemifts who have examined the action of the acids upon the bile in detail, have remarked that at leaft three different cryftalline matters were obtained from the filtrated liquors: that

that which the acid employed muft form with the foda, and they have all recognized the fulphate, the nitrate, the muriate or the acetite of foda in fuch a manner as not to leave the fmalleft doubt: a fecond falt, conftantly obtained in their experiments, has been defcribed as fmall needles, and taken for a calcareous falt formed alfo by the acid employed and lime, the prefence of which they have thus admitted in the bile; and laftly, a third cryftalline matter in trapezoids, of a weak and fweetifh tafte, which Cadet has confidered as a matter analogous to the fugar of milk, which Van Bochaute has afterwards fought by many different proceffes, and the prefence of which is not yet accurately proved, though traces of it have been rather decidedly found in the fweetifh tafte of the extract of the bile, in its property of paffing into a kind of vinous fermentation defcribed by Van Bochaute, and in feveral other facts that fhall be fucceffively indicated.

15. We fee at leaft, from thefe details, that the acids act in three ways at once upon the bile: they coagulate its albumen which is precipitated in maffes; they feparate its oily matter by feizing the foda which held it in faponaceous folution; they decompofe the phofpheric falts, efpecially the calcareous, and that with foda for its bafe, when the acids employed are more powerful than the phofphoric: for I have already fhown that thefe phofphates are contained in the bile. It is therefore not difficult to con-

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ceive why chemifts have fo greatly multiplied their experiments upon the treatment of the bile by the acids, and how they have availed themfelves of this treatment for determining its properties as well as its compofition.

There are fome particular facts to be known concerning the fpecies of acids with refpect to their manner of acting upon the bile. The concentrated fulphuric acid coagulates it in denfe flakes, and gives it a deep colour; the weak fulphuric acid renders it intenfely green. The nitric, after having precipitated it green in the cold, affumes a golden-yellow colour with it when it is heated for a fufficient length of time; it converts part of it into oxalic and into Pruffic acid, and alters its oily matter. The muriatic acid, which at firft precipitates it of a green colour, afterwards affumes a violet caft, efpecially by the action of heat. The oxigenated muriatic acid whitens it and renders it turbid like milk; it changes the nature of the albuminous principle, of the oily fubftance and of the colouring matter of the bile: it precipitates from it filaments fimilar to thofe which frequently conftitute the biliary calculi; its action ftill deferves to be examined anew, and attentively ftudied by chemifts.

16. The precipitate formed in the bile by the acids is compofed of two principal matters: the one, which is manifeftly an animal fubftance; the other is a fort of oily body, upon the nature of which chemifts are not yet agreed. Thefe two matters

matters are feparated by means of alcohol, which diffolves the latter without touching the firft. This alcohol acquires a brown-yellow colour in proportion as it diffolves the oily fubftance. If we let it evaporate fpontaneoufly in the air, there feparate from it at its furface fome drops of an oily liquor, which has the fmell and the acrid bitternefs of myrrh, with which feveral chemifts have compared it: and there is depofited from it a tenaceous ropy matter, of a deep brown colour, which does not inflame upon ignited coals, which is ftill foluble in alcohol, but infoluble in water. The folution of this fubftance in alcohol is abundantly precipitated by water, and the collected depofition foftens over a gentle fire. All thefe properties have induced Van Bochaute to confider it as a refin, which he has compared with that of the jalap, and which he believes to be almoft of a vegetable nature. But the refins properly fo called are not foluble in fixed alkali, and do not form real foap: it is therefore a matter not really refinous, but oily of a particular kind, which feems to approach, as I fhall foon fhow more in detail, to what I call adipocire.

17. When the precipitate of the bile has been treated and difcoloured by alcohol, till this no longer takes up any thing from it, there remains a white or grey matter, not fufible in the fire, infipid, or fcarcely at all bitter, infoluble in cold or hot water, foluble in the leys of cauftic fixed alkalis, which burns

upon the coals with a ſmell of horn, and affords, in its analyſis by the retort and by the different re-agents, altogether the ſame products as this laſt-mentioned ſubſtance, more eſpecially an abundant quantity of carbonate of ammonia. Its coal contains a remarkable quantity of phoſphate of lime; it is therefore a well characterized animal ſubſtance. Some modern chemiſts have believed it to be compoſed of two ſubſtances, of gelatinous mucilage, or gelatin and of albuminous matter. But this opinion is not ſupported by experience; for it has not been proved that water forms jelly with this portion of the precipitate of the bile; and it ought manifeſtly to form it if it contained the gelatinous ſubſtance. On the contrary, Verheyen, Cadet, Van Bochaute, and Marherr, have all compared it with horn, both in its combuſtion and in its diſtillation, which announces its analogy with the albuminous ſubſtance.

18. The alkalis do not exert ſo powerful an action upon the bile as the acids. It has been ſtated that they deprive it of its bitterneſs. They do not coagulate it; but they render it ſenſibly more fluid; and they alter its colouring matter but very little. The ſolutions of barites, of ſtrontian and of lime, form in it at firſt a light precipitate which is an inſoluble earthy phoſphate; a larger portion of theſe ſolutions ſeparates from it the oily matter, with which the earths form an inſoluble ſoap. The fixed alkalis well concentrated diſengage a very perceptible ammoniacal

moniacal ſmell, and thus demonſtrate the preſence of an ammoniacal ſalt in it, which probably is a phoſphate. The ſalts have but very little effect upon the bile, if we except the ſoluble earthy ſalts, all which precipitate it, and form earthy ſoaps, by decompoſing the ſoap of ſoda which it contains. The ſame is the caſe with the metallic ſalts: moſt of them decompoſe the bile, and are decompoſed by it; they form precipitates compoſed of coagulated albumen, of metallic ſoap, of metallic muriates and phoſphates. Accordingly, we ſee that theſe ſalts, adminiſtered in medicine, eſpecially in the ſmall doſes in which they are given, undergo in the firſt inteſtines, and ſometimes even in the ſtomach, a decompoſition which renders their action either feeble or different from what medical theory has hitherto repreſented it.

19. Amongſt the vegetable matters, it unites with all that are ſoluble in water: it has been quoted as acting particularly upon the oily ſubſtances; and hitherto all the chemiſts have ſo poſitively attributed to it the property of diſſolving the fixed oils eſpecially, that it is even on account of this property that it has been conſidered as a ſoap; it is to this that they aſcribed its action in digeſtion as well as that which it exerts in the fuller's art. Van Bochaute had even advanced, with reſpect to the latter uſe, that the bile was the moſt ſoluble ſoap, which took out ſpots of oil and greaſe from cloth

cloth with more energy than any other known ſoap. However, Profeſſor Joſ. Ja. Plenck, in his Hygrology of the Human Body, publiſhed at Louvain, in 1797, in which he has employed moſt of the new facts for which the ſcience is indebted to the French chemiſts, without once quoting their authors, ſays poſitively that the bile contracts no union either with the fixed or the volatile oils; that it does not diſſolve them, nor render them miſcible with water; that, as a compound of reſin and alkali, the latter in too ſmall quantity, it is not a ſoap, nor ſoluble in water, like a ſoap. He adds, in order to explain its action upon linen and cloth impregnated with oil, that it has more affinity for the texture of theſe ſtuffs than oil has, and that it does nothing more than take their place, by reaſon of the form of its particles. It is true, this author does not quote any particular experiment, neither does he indicate the ſource from whence he has derived this new reſult concerning the nature of the bile; undoubtedly on account of the brevity and the aphoriſtic form which he wiſhed to give to his work. I have examined, according to this aſſertion, the action of the bile upon the oils; and have found that it diſſolves in a very decided manner theſe liquids, with which it forms kinds of emulſions, and that it conſtantly renders them eaſily miſcible with water. Conſequently, the aſſertion of Mr. Plenck, in this reſpect, is erroneous.

20. Alcohol

20. Alcohol poured upon the bile produces in it a ſpeedy coagulation, and ſeparates from it flakes of ſlightly-coloured albuminous matter; it afterwards holds in ſolution the biliary ſoap and its colouring matter. Applied to the extract of bile, or to the bile inſpiſſated by the action of the fire, alcohol diſſolves its ſoapy part and the colouring ſubſtance, but does not attack the animal albuminous part. Ether ſeparates but very little matter from it. Theſe two ſolvents having been employed with much care by Van Bochaute, and having afforded him ſome remarkable reſults, I ſhall here quote the principal experiments, as they may be particularly uſeful to thoſe chemiſts who may undertake new inquiries relative to this animal liquor;—inquiries called for by the national inſtitute of France, in the queſtion which they have propoſed concerning the nature of the bile, and the function of the liver.

Van Bochaute having evaporated to dryneſs bile that had firſt been combined with an equal quantity of water, and which had not been coagulated by ebullition, treated this extract by hot alcohol till this liquor ceaſed to become coloured, and left only the animal ſubſtance. He obtained a tincture of a brown-yellow colour, which afforded, by evaporation, an abundant quantity of matter tranſparent like gum, of a ſweet and honey-like taſte, mixed at laſt with a degree of bitterneſs, ſoluble in water, which kept more than eighteen months without

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alteration, and which he has propofed as a much better remedy than the fimple extract of the bile. He confidered this alcoholic extract as the biliary foap mixed with faccharine matter, and well feparated from animal fubftance, which he calls *glutinous*, though it is very manifeftly our albuminous matter, as the facts hitherto quoted evidently prove.

21. Van Bochaute has made feveral remarkable experiments upon the diftillation of this alcoholic extract of bile. He obtained from it the fame products as from a gum-refin; its coal contained a notable quantity of foda. Its folution in water, which was very tranfparent, not milky, was decompofed by the acids, and gave a precipitate which he calls *refinous, fat, pitchy*, which adhered to the fingers like turpentine, was intirely foluble in alcohol, to which it gave a brown-yellow tinge, and was feparated from it by water, like the refin of jalap. This alcoholic folution of what he calls the *refin of the bile*, a refin precipitated, as we fee, from the aqueous folution of the alcoholic extract of this humour, expofed to the air in a veffel covered with paper, prefented to him after fome days, and after the reduction of the liquor to a third of its original volume, a fupernatant oil, tranfparent, of a gold-yellow colour, and of a bitter fmell and tafte, refembling thofe of myrrh. At the bottom of the liquor a refin was precipitated, thick, tenacious, lefs bitter and lefs odorous than the

oil,

oil. From thefe experiments he concludes, that the oily matter combined with the foda in the bile, is a true refin, analogous to the vegetable refin, combined with an oily, aromatic, and bitter principle, fimilar to that of myrrh, and that thefe two bodies intimately united are, like the aromatic vegetable refins, the product of a thickened volatile oil. We fhall foon fee that this inference is not accurate in the comparifon which it eftablifhes; but that the mode and the phenomena of this experiment are neverthelefs remarkable, and deferving of all the attention of the chemifts.

22. The action of ether upon the extract of bile, prefented to the author experiments no lefs interefting; and though he has not followed it fo far as it requires, and as he had promifed, his refults are neverthelefs worthy of a place in the chemical hiftory of this animal humour. Van Bochaute, not fatisfied with the firft experiments of Cadet, upon the extraction of the fugar of milk from the bile, by the evaporation of the mixtures of this liquor with the acids, (experiments which, being founded merely upon the trapezoidal form, and the fweet or infipid tafte of thofe cryftals, left much doubt in his mind) tried particularly the action of ether, with the view of feparating this particular matter of the bile, announced already with fufficient certainty by the fweet or even honey-like tafte of the alcoholic extract of this liquor, and by the figns of vinous fermentation which he had obferved

obferved in it. For this purpofe, he put dry extract of bile into very pure and highly rectified ether: he left this mixture in a well-clofed veffel, which he frequently agitated during fourteen days. At this period the liquor was fcarcely coloured: a portion being decanted, and left to fpontaneous evaporation in an open veffel, prefented to him on the following day an aqueous liquid of an etherated odour, upon which fome drops of oil floated; this oil, collected upon paper, had a bitter tafte like myrrh, and the refinous confiftence; the liquor beneath was fweet and flightly faccharine. The author who had much confidence in this experiment, confidered it as a proof and a product of the decompofition of the biliary foap; he thought that the ether favoured and effected the feparation of its oleo-refinous part; and that by accomplifhing this complete feparation, by means of a feries of fimilar experiments, he fhould fucceed in obtaining the faccharine matter infulated, or mixed only with foda, from which he fhould eafily be able to feparate it. If he fhould not thus obtain the fugar of the bile fufficiently pure and well feparated, he hoped to fucceed by recommencing and following up this experiment repeated upon the alcoholic extract; for that of which I have juft given an account, was made upon the fimple extract, or the intire bile, infpiffated by the fire. Van Bochaute intended to give the refults of this experiment, as foon as his avocations

1 fhould

ſhould have permitted him to follow it up with the requiſite attention and leiſure; but he has given nothing ſince, for he was ſnatched away by death from chemiſtry and medicine before he could put the finiſhing haud to this intereſting reſearch.

23. The action of the bile upon the different animal liquors and ſubſtances has not yet been examined, though this examination might and muſt throw the greateſt light upon the phenomena of the animal economy. Hitherto, only its mixture, its eaſy union, and its analogy with fat, have been ſpoken of; but it is chiefly by vague views of the hiſtory of diſeaſes, and without direct experiments, that this object has been treated, as we may ſee in a Memoir of Lorry, inſerted among thoſe of the Society of Medicine. Some have pretended that the bile coagulated milk; others have denied this property. Schroeder, Profeſſor at Gottingen, employed this coagulation of milk by the bile, as an argument againſt the ſaponaceous quality of the latter; and Marherr has ſince renewed it in order to ſupport the ſame opinion, and to prove that the action of the bile depended more upon its mucous nature, than upon its ſaponaceous quality. There is reaſon to believe, that it was upon the authority theſe two phyſicians that Plenck denied the biliary ſoap, as I have already mentioned, No. 19. Some indications collected from the experiments of Van Bochaute ſeem to announce that the bile retards or prevents,

vents, or at leaſt diminiſhes the coagulability of the albuminous ſubſtance. The effects of the bile upon the blood, the ſaliva, the gaſtric juice, the pancreatic juice, &c. are altogether unknown. Theſe hints ſhow how intereſting the reſearches concerning the reciprocal action of the bile, and of the different animal matters will be, and how much this kind of experiments ought to be inſiſted upon by thoſe who, at preſent, intend to treat the grand queſtion of the analyſis, and the uſes of the hepatic ſyſtem, propoſed to the learned world by the National Inſtitute of France.

24. All the known facts relative to the chemical properties and the analyſis of the bile, which I have collected in this article, ſhow that this liquid is of a very compound nature, and that it eſpecially differs from moſt of the other animal ſubſtances that have hitherto been examined. It contains, as has either been proved by the facts enunciated, or indicated according to experiments more or leſs advanced.

A. A large quantity of water.

B. Soda.

C. An oily matter united with the latter in the ſaponaceous ſtate.

D. A colouring matter combined with the preceding kind of ſoap.

E. A bitter and odorous oily ſubſtance.

F. A coagulable animal ſubſtance.

G. A kind of ſaccharine ſubſtance analogous to the ſugar of milk.

H. Salts

H. Salts of feveral kinds.

I. Laftly, oxide of iron.

We muft re-confider each of thefe principles in particular, and inquire how they have been found or announced in the bile, determine their ftate, their particular or fpecific nature, the mode of their combination, and their influence upon the properties of the biliary liquor, in order to arrive at the determination of its ufes in the animal economy.

SECTION. IV.

Of the different Materials of the Bile feparately confidered.

25. WATER is certainly the moft abundant material of the bile; it is the vehicle and common folvent of all the principles that conftitute it; it is that to which they owe their liquidity. Its proportion varies much, according to the different ftates of confiftence which this humour affects. It is feparated or driven off by the action of fire, and efpecially by diftillation. On the water-bath it carries with it fome light materials of this fubftance, which give it a faintifh eafily recognizable odour, and fometimes a fmell of mufk: the latter generally takes place only when the bile that is diftilled has already been previoufly corrupted. The firft frequently

frequently paffes into the aromatic ftate of the fecond, after fome time, and by a kind of fermentation. No chemift doubts either the prefence or the abundance of water in the bile. It is remarkable, that it is abfolutely impoffible to extract it in a pure ftate; and that, in its feparation by the fire, we only obtain it united with a biliary principle which gives it odour, and which is alterable. This principle is frequently fufficient to precipitate the acetite of lead in a white ftate. It would be of great importance to know whether this water exifts ready formed in the blood, and be only feparated from it in the liver, or whether it be not in this vifcus itfelf that it is formed as the expenfe of the blood; which would explain the origin of the oily matter which is fo abundant in the bile, according to the much more hidrogenated ftate of the blood.

26. *B*. The prefence of foda is as fatisfactorily proved in the bile as that of water. This alkali manifeftly exifts in it in the cauftic ftate; and it is on this account that, fifty, and even thirty years ago, the alkaline nature of this humour was denied, becaufe it did not effervefce with the acids; an indication of the prefence of the alkalis, which was then admitted only becaufe neither the carbonic acid nor the carbonates were known. Though the foda is in the faponaceous ftate in the bile, the acids which feparate it from its oil, fhow that this alkali is contained in it in a much lefs confiderable quantity

quantity than it ſhould ſeem it ought to exiſt in it, in order to conſtitute a true and perfect ſoap. It is this ſoda which, remaining in the coal of the bile after the diſtillation of that liquor, gives it the property of immediately turning the ſyrup of violets green, and effloreſces on the ſurface of the coal by long expoſure to the air. The ſource of the ſoda of the bile is eaſily found in the alkaline nature of the ſerum of the blood: it eaſily ſeparates from this liquid, in which it is almoſt inſulated, on account of its weak adheſion with the kind of oil which is found developed in the tubes of the liver. Its proportion has not been determined, and it is one of the moſt eſſential of the points which ought hereafter to engage the attention of the chemiſts who devote themſelves to the cultivation of animal chemiſtry.

27. *C.* The oily matter, combined with ſoda, is one of the moſt extraordinary principles of the bile. Its nature was not explained in chemiſtry till a conſiderable time after both its exiſtence and its ſaponaceous form had been diſcovered. Van Bochaute, who firſt occupied himſelf with it in particular, has compared it to the reſins, and even thought that it approached the nature of the vegetables: he founded this opinion upon the circumſtance that this oily body, ſeparated by the acids, taken up afterwards by alcohol and obtained from this liquid by evaporation, aſſumes a pitchy conſiſtence, a tranſparent and dry ſtate, is conſtantly ſoluble in

in alcohol, and is precipitated from it in ſmall white drops, which remain long ſuſpended in the liquor, and which may be rendered ſoft and ductile by the action of heat. Van Boehaute thought that this reſinous matter might proceed from the red globules of the blood, in which Gaubius had already remarked a diſpoſition to become reſinous. The profeſſor of Louvain adopted with reſpect to this ſubject the theory of Roux, Profeſſor of Chemiſtry at the School of Medicine at Paris, who conſidered the bile as the natural evacuant of the colouring part of the blood. But theſe ideas, which are ſtill more vague than ingenious, muſt give way to new reſearches and new experiments. In order to ſhow their utility, and that theſe reſearches may be commenced under new auſpices, I ſhall here quote the reſult of ſome experiments which I inſtituted in 1790 upon the oily matter of the bile, and which ſhow the exiſtence of ſomething very different from a reſin.

28. *D.* The oxigenated muriatic acid, received in the ſtate of gas into bile, diluted with a little water, quickly deſtroys its colour, and coagulates the albumen, which is depoſited in white flakes: its ſoap remains in ſolution without either colour or ſmell, but retaining its bitter taſte. A larger proportion of this acid re-acts again upon this ſoap, and ſeparates from it the oily matter, white, and in a concrete form. Any acid poured upon the bile already diſcoloured by the oxigenated muriatic acid, immediately

immediately produces in it a white concrete precipitate of the consistence of fat, which dissolves in hot water, in cold alcohol, and causes the latter to pass into the state of ether by the action of heat. This adipo-alcoholic solution, thickened to the consistence of a syrup in the air, combines with water without being precipitated: an acid decomposes it. The white concrete matter, seemingly adipocirous and not resinous, precipitated from the bile by the oxigenated muriatic acid, was first taken for the foliated substance contained in the biliary calculi, of which I shall speak in the next article; but it differs from it by its greater softness, by its fusibility which takes place at 32 degrees of Reaumur, by its greater solubility in alcohol, and by its solubility in hot water. These experiments ought to be pursued with assiduity: it would be necessary especially to inquire whether this white precipitate of the bile by the oxigenated muriatic acid be not the biliary soap, still alkaline on account of its attraction for water; and this is the more essential as we should not forget to remark, with regard to the fatty and colouring matter precipitated from the animal liquor by the acids, that when we attempt to wash it with water after its precipitation, this liquid carries off a considerable part of it, which it dissolves as if it were still a soap, and that the water of lixiviation is precipitated again by the addition of an acid. I have also remarked that the acid liquor, which

has always a green and sometimes a very brilliant colour, is precipitated by evaporating a portion of colouring matter, of a green cast and a pitchy consistence. Thus the oily substance of the bile is of a very singular nature, and of a very particular kind; it is neither fat, nor resin, nor adipocire, properly so called. Its character, as intermediate between these three bodies, seems to consist in imitating all three, or differing from each, accordingly as it is treated by different processes. The true mode of its difference, depending on its intimate nature and the proportion of its principles, is not yet known, because the analysis of the fatty substances is not yet sufficiently advanced; and it must be the work of future investigations to determine the simple ideas which exist relative to this subject, especially by ascertaining its relations with the abdominal fat from which it manifestly derives its origin.

29. *D.* The same may undoubtedly be said also of the colouring matter of the bile, which we have not yet been able to obtain separate from the fatty substance, and which adheres intimately with it, so much so indeed, that it has been very naturally confounded with it, and considered merely as a characteristic attribute of the biliary oil. Thus Van Bochaute, notwithstanding all the ingenuity with which he has conducted his experiments, destined particularly for insulating the different constituent matters of the bile by analysis, when he presents, as the general

general refult of his inquiry, this humour as a compound of much water, of albuminous mucus, partly infulated, partly united with an animal gluten, of a foap formed of refin and foda, of much faccharine mucous matter, and of a particular aroma or *fpiritus rector*, does not mention the colouring matter amongft the principles which he admits in the bile. Though analyfis has not yet decided upon this important point, the colour of the bile, whether confidered as a particular matter, or as a characteriftic property of its particular oil, appears to be, according to the experiments already defcribed, very much difpofed to the green or brown-yellow caft, very much fubject to variation, capable of being made to difappear by the action of the oxigenated muriatic acid, and confequently not proceeding from iron as fome chemifts had thought.

30. *E.* I fpeak here of the bitter and odorous fubftance extracted from the bile by feveral chemifts, and defcribed efpecially by Van Bochaute, only in order to difcufs the queftion relative to its exiftence or its accidental formation, perhaps owing to the experiments themfelves, by which it has been obtained. It appears that the latter opinion was adopted by Van Bochaute himfelf; for in his conclufions upon the compofition of the bile, and in his enunciation of its principles, he has not comprehended this fpecies of oil: and in fact it was feen only in the form of fome drops that fwim upon the

alcoholic and etherated ſolution of what he calls the *reſin of the bile,* or of its *ſoap;* there were ſeparated from it merely ſome tranſparent drops which he could collect only upon paper; he conſidered them himſelf as a product of the decompoſition of the biliary reſin, as he hoped thereby to ſeparate and to obtain in ſufficient purity the ſaccharine mucous ſubſtance when he ſhould have decompoſed it completely. This oil, to which the ſame author appeared eſpecially to aſcribe the ſmell of muſk or of myrrh which the bile acquires, particularly at the moment when the oily ſubſtance is diſengaged from it, is therefore a modification of its oily matter, one of the ſtates which it aſſumes in the alterations which art gives to it; perhaps even its form of tranſparent, volatile and odorous oily drops depends upon its union with a little of the alcohol or ether required for its extraction. It ought therefore to be conſidered only as one of the properties of the biliary oil, and not as one of the principles of the bile: it has never been found in it ready formed.

31. *F.* The coagulable animal matter of the bile was not diſtinguiſhed in the firſt periods of its analyſis. Cadet, who occupied himſelf only with the ſaponaceous nature of this fluid, and the ſaccharine ſubſtance which it appeared to him to contain, has ſaid nothing concerning this matter. Van Bochaute has paid much attention to it; but he has not well

well determined its nature; he has particularly mentioned, as well as Verheyn, its property of burning with a fmell of horn. He has defcribed the means of extracting it from the precipitate of the bile by the acids, by carrying off its oily matter by means of alcohol: he has remarked the property of not coagulating by ebullition, which is communicated to the biliary foap when water is added to it; but he had not an accurate idea of its characters, and he has defcribed it as a kind of animal mucilage, partly infulated, and partly united with gluten, though lefs than in the ferum of the blood. Hence it is evident that he believed the animal matter contained in the bile to be of two kinds; the one albuminous and coagulable by the acids; the other gelatinous. I have not had occafion to recognize thefe two fubftances in the bile. If they both exift in it at the fame time, which is not improbable, becaufe this mixture takes place in feveral animal liquors, the action of the acids upon the bile ought to feparate from it only the albuminous matter, which they have the property of coagulating at the fame time as the oil, and to retain in folution the gelatinous fubftance. Van Bochaute therefore cannot have found thofe two matters in the precipitate of the bile by the acids; for the gelatin can be feparated only by the evaporation of the fupernatant liquor. This laft has not yet been proved to exift in the bile, and hitherto there has only been found in it the albuminous fubftance which

which, renders this liquor ropy and viſcid, and the proportion of which varies according to a number of circumſtances.

32. *G.* The ſaccharine ſubſtance, or the ſubſtance analogous to the ſugar of milk, which Cadet firſt announced in the bile, but which he has not demonſtrated to exiſt in it by ſufficiently accurate experiments, has formed, as I have already indicated, one of the principal objects of Van Bochaute's reſearches. The latter was not able, notwithſtanding the different means which he employed, to inſulate this principle and render it ſenſible. He judged of its preſence only by the ſweetiſh taſte of the extract of the bile, and by the commencement of vinous fermentation which he thought he obſerved in it. We are however aſtoniſhed, when we reflect how little ſucceſs he obtained, to find this author in his recapitulation, enumerating the ſaccharine mucous ſubſtance amongſt the moſt abundant principles of the bile, and even indicating it as being very analogous to ſugar. It is impoſſible to accede to the opinion of Van Bochaute, while no proceſſes have been diſcovered for better proving the exiſtence of this ſaccharine matter in the bile. Such a ſubſtance ſhould rather appear to be foreign to this oily, acrid, and bitter liquid, were it not conſidered, on the one hand, that indications ſeen by able chemiſts ought to call upon their ſucceſſors to confirm them by new reſearches, and on the other, that it would not

be

be extraordinary if a liquor, formed in part by the abſorption of the products of the inteſtines, ſhould contain a portion of chylous matter. Thoſe notions therefore deſerve to be followed up by farther reſearches; and if the ſaccharine matter actually exiſts in the bile, we ſhall be led to regard it as one of the recrementitious ſubſtances which this humour carries into the organs of chylification.

33. *H.* The chemiſts who have hitherto occupied themſelves with the analyſis of the bile, have written ſcarcely at all concerning the nature of the ſalts that are contained in it; they have almoſt all operated by treating it with the acids; and they have confounded the ſalt formed by this addition with thoſe which form integrant parts of this liquor. I have ſhown, by the re-agents, indications of phoſphoric acid and of lime in the bile. The ſoda is equally ſuper-abundant to the ſaline combination, ſince the exceeding part exiſts in it in the ſaponaceous form. It is therefore certain that this humour contains phoſphate of ſoda and phoſphate of lime. There have beſides been found in it ſome indications of muriate of ſoda. There is reaſon to believe that the ſaponaceous and albuminous ſtate of this liquid contributes to render the calcareous phoſphate ſoluble in it; for it cannot exiſt in the ſtate of phoſphoric acid, on account of the ſoda which is almoſt inſulated in it. We ſee the ſame circumſtance of the ſolution of this

earthy

earthy phoſphate in the animal liquors. Sometimes this phoſphate of lime is ſufficiently abundant to form concretions as in other regions of the animal body. I have ſeveral times found ſome, of this nature, in the texture of the liver of certain animals, and eſpecially of birds.

34. *I.* Hitherto iron, in the ſtate of oxide, has been reckoned amongſt the conſtituent materials of the bile; and it appears that Gaubius, in his Lectures, believed this oxide to be the cauſe of its colour. But without denying the poſſibility of the exiſtence of this metal in the biliary liquid, though its coal but rarely preſents any but merely ſlight traces, we cannot be permitted to attribute to this metal the ſource of its yellow or green colour, becauſe this colour is ſo eaſily altered by the oxigenated muriatic acid. The iron is therefore only a principle in ſome meaſure accidental in the bile, and does not ſenſibly influence its nature or its properties. Formed entirely at the coſt of a venous blood ſingularly retarded in its courſe, it would be aſtoniſhing if the bile did not contain the ferruginous ſubſtance which is ſo eaſy to be exhibited in the ſanguineous liquid; and we might even rather find the ſmallneſs of the quantity of this metal exiſting in the bile a ſubject of embarraſſment, if we were not accuſtomed to ſee ſeveral liquids ſeparated from the blood which contain none at all of it. Neither do we know in what ſtate the ſmall quantity of iron that has been indicated in the bile exiſts;

and if, as in the blood that furnifhes it, this metal be not combined with the phofphoric acid, it affords another fubject of refearch which the chemift ought not to neglect.

35. The nature of the texture of the liver, though not yet analyfed comparatively with other vifceral parenchymas, has prefented fome facts which may throw light upon its functions, and which muft here be collected. I have already remarked that this texture has not a bitter tafte, and that it thus indicates that the hepatic bile differs effentially from the cyftic. In the year 1785, I had occafion to examine chemically a portion of human liver, that had been fufpended for ten years in the air, in the laboratory of Poullatier de la Salle. This parenchyma, after having undergone the phenomena of a flow putrefaction, refembled a friable and light earth; and the firft notion of a chemift, at the fight of it, would formerly have been that it was actually reduced to its earthy fkeleton. It was, however, fatty, fmooth, and, as it were, faponaceous under the finger; upon an ignited coal it was foftened, melted, blackened, and reduced to coal; exhaling at the fame time a fmell of fat; it afforded me water flightly ammoniacal, a concrete and lamellated oil, carbonated hidrogen gas, and a light coal in the retort; boiling water diffolved a fmall quantity of it, and affumed a faponaceous character; the refiduum, which was more oily or greafy cryftallized as it cooled, and inflamed

with

Section V.

Of the Varieties of the Bile in the different Animals.

37. WHAT has been done with regard to the analyſis of the bile of the bullock, the fluid moſt commonly examined, proves that this liquid ought to be conſidered as an albumino-ſaponaceous liquor, compoſed of water, of albumen, of ſoda, of a particular concreſcible oil, of phoſphates of ſoda and of lime; that the colouring principle, the volatile and odorous oil reſembling myrrh, are only products of the alteration of this liquid; that the mucoſo-ſaccharine matter is not proved to exiſt in it; and that the iron is only accidental to it. The materials that have been firſt indicated form the principles of the bile, and the experiments that have hitherto been made upon the human bile compared with that of the bullock, have not ſhown any differences between theſe two liquids. But we are not authorized to conclude, from theſe two analyſis, that the bile is of the ſame nature in all animated beings. There is reaſon to believe that the ſpecies of mammalia that have no gall-bladder, and poſſeſs only hepatic bile, have a particular character in this liquid, in particular leſs acrimony and bitterneſs.

38. Nothing

38. Nothing has yet been done refpecting the analyfis of the bile, as confidered in the different orders or genera of animals; the varieties in the nature of the biliary liquid which the difference of organization in the vifcera muft produce have not yet been examined. Anatomy, more advanced in this refpect than chemiftry, teaches, however, that the hepatic fyftem or apparatus, which, as I have already faid, is conftant throughout the whole feries of animated beings, having a ftructure more or lefs remote from the original type or the original model which we find in man and in the mammalia, the different animals muft alfo have a diverfity of nature in their bile. Undoubtedly the bile of the carnivorous and the frugivorous birds, whilft it differs in thefe two grand claffes of bipeds, differs ftill more from that of man and of the mammalia. Still more muft there exift a peculiar character in the bile of the amphibia, of fifhes, of the teftacea, of infects, and of worms. Much ufe was formerly made in medicine of the bile of the carp, of the pike, and of the eel; it was prepared in pharmacy by evaporation, and it was infpiffated to an extract. The art of performing this fimple operation has fhown that this liquid is of a deep and brilliant green in fifhes: that it is not fo vifcid as that of man, and the mammalia; that it is lefs bitter; that it thickens like a varnifh; that it attracts the humidity of the atmofphere when it has the form of extract; that

that it is very mifcible with water; that it becomes turbid, and precipitates whitifh flakes by the addition of alcohol, which itfelf remains green.

39. Hitherto I know only of an analyfis of the liver of the fkate, made by Citizen Vauquelin, which, whilft it proves the adipofe nature of this vifcus, announces that the bile of the amphibia and of the fifhes muft be more oily than that of the mammalia and of the birds. It was already known in the kitchens, that when the liver of the fkate, which is foft and of a reddifh-grey colour, is boiled in water, it affumes a firmer confiftence than it had before, and lets fome oil efcape, which is feen fwimming upon the furface of the liquor. This oil does not become fixed at fixty degrees of temperature. Triturated with water in a mortar, the liver of the fkate prefented to Citizen Vauquelin a fort of emulfion or oil, which gradually feparated at its furface, and was decompofed by the acids. Paper is greafed by this vifcus, and the fyrup of violets is turned green, becaufe the liver of the fkate, when examined at Paris, at a diftance from the fea-ports, is already flightly altered. The red colour, given to turnfole paper by an acid, and again converted into blue by this liver, paffes again into the red, in the air, by the volatilization of the ammonia, the prefence of which is proved by this change. When bruized fkates' liver is flightly roafted, fome drops of oil iffue from it; and

and when afterwards ſubjected to the preſs, it yields more than half its weight of oil: the portion of parenchyma which remains after this expreſſion, when burned in a crucible, leaves pure phoſphate of lime as its aſhes. The oxigenated muriatic acid, poured upon the oil extracted from the liver of the ſkate, renders it immediately white, whilſt at the ſame time it loſes its ſmell, and gives it the conſiſtence of fat; this oil, expoſed to the air, becomes white, concrete, and opaque. Citizen Vauquelin concludes from this examination, that the liver of the ſkate (and the bile of this animal undoubtedly partakes of the ſame nature,) is charged with a liquid oil in very large quantity. He compares this fact with the livers of fattened animals, and eſpecially thoſe of geeſe, which are very ſweet, very fat, and of a pale colour, and with morbid circumſtances under which the human liver and that of the mammalia becomes tumefied, white or grey, and aſſumes the fatty character which that of the ſkate preſents. He attributes this oily nature, and eſpecially this liquid oil, to the circumſtance, that the blood of the abdominal viſcera, being very much retarded in its courſe, eſpecially in the animals that reſpire little, becomes much hidrogenated in proportion as its carbon unites with the oxigen abſorbed by this fluid, and that it is on account of the extreme ſlowneſs of its motion in the ſkate, that the oily matter formed in it remains always liquid.

 40. This

40. This ſingle circumſtance of the analyſis of the liver of the ſkate, which affords ground to believe that the bile follows the oily kind of compoſition in this animal, and which ſhows a remarkable relation between reſpiration and bilification, is ſufficient to ſhow how many important reſults in phyſiology and medicine might be derived from the experiments made on this humour, compared in the different genera of animals; how many uſeful concluſions in animal phyſics, and the art of healing, may be expected from the careful execution of the plan of reſearches propoſed by the programma of the national inſtitutes. How much may not be expected, when the zeal of chemiſts ſhall engage them to purſue this important inveſtigation in the different ages of man, and of the animals, in the fœtus that has not reſpired, in ſubjects afflicted with pulmonary diſeaſes, and in whom the impeded reſpiration ſeems to be reduced to a condition ſimilar to that of the amphibia, in all the affections in which this liquid aſſumes ſo many characters and properties which cauſe it to differ from its natural ſtate? How many problems, not only hitherto undetermined, but even yet unthought of, will reſult from theſe numerous and uſeful experiments, which have ſcarcely been commenced, and are already ſo important, on account of the views which they afford to the ſcience of healing.

SECTION VI.

Of the Uses of the Bile in the Animal Economy during Life.

41. I HAVE but little to ſay here reſpecting the uſes of the bile, becauſe this ſubject will be treated in its proper place in the fourth order of facts, which will conclude this eighth and laſt ſection of my work. I ſhall confine myſelf, in the preſent article, to the general facts that are inſeparable from the chemical hiſtory of the bile. Till the period when chemiſtry enlightened animal phyſics concerning the formation of this humour, reſpecting its relations with the abdominal blood, with reſpiration, with the fat, phyſiologiſts limited themſelves to conſider of the bile as a liquid uſeful and neceſſary to digeſtion, by its property of mixing oils with water, and conſequently of forming the chyle. But the notions that flow from the preſent reſearches are much more comprehenſive; and, we may affirm with truth, that they have opened a new career for the progreſs of animal phyſics.

42. It is well known, that the ſecretion of the bile conſiſts in its diſcharge into the duodenum. Haller believes, and beſides the weight of this author's opinion, the

 notion

notion is ſupported by ſimple and accurate reaſoning upon the anatomical ſtructure, that the hepatic bile deſcends much more abundantly into the inteſtines than into the gall-bladder, and that only a ſmall portion of it paſſes into this reſervoir by a kind of overflow. So that the hepatic bile flows inceſſantly from the liver into the inteſtinal tube; but the cyſtic bile arrives in it only at certain periods, by the change of ſituation in the abdominal viſcera. It is at the moment when the aliments being already diſſolved and digeſted, arrive in the duodenum, that the bile of the gall-bladder, which is elevated towards its bottom, evacuates itſelf and flows into the duodenal cavity after having been mixed either with the hepatic bile, or with the pancreatic juice, the excretory duct of which unites with the extremity of the ductus choledoctus within the ſides of the inteſtines themſelves. The changes which it experiences, by its mixture with this laſt-mentioned juice, are hitherto unknown; for the ſimple notion of its diviſion, its attenuation, and its mollification by this juice, is little ſatisfactory to the mind accuſtomed to obſerve that nature, in her admirable economy, does not go to the expenſe of creating a glandular viſcus, for the mere purpoſe of diluting a humour, to which ſhe would have contented herſelf with giving more fluidity in its own ſecreting organs; and the leſs ſo, as we ſee on the other hand, in this theory, no uſe for the gall-bladder, except that of ſerving to thicken

thicken the bile. Were theſe notions juſt, it would follow that thoſe animals which are deſtitute of a gall-bladder, and in which the bile is not ſo thick, muſt have no pancreas; whereas frequently, on the contrary, this gland is more perfectly formed in them than in the animals which have a gall-bladder. We are not therefore yet in poſſeſſion of the whole truth reſpecting this ſubject.

43. The bile, poured upon the alimentary maſs digeſted in the ſtomach, appears there to undergo a decompoſition, of which nothing is ſaid in the works on phyſiology. Beſides that the aliments are generally more or leſs acid, which is ſufficient for the precipitation of the biliary humour; had they not this character, their very compounded ſtate would be ſufficient to render it conceivable that the ſlight equilibrium of the compoſition of the bile could not reſiſt it. It undergoes a precipitation, it is divided into two matters like the chylous maſs itſelf; the one liquid, containing the alkali, the ſalts, with part of the animal ſubſtance, and the ſaccharine ſubſtance, if it be preſent, combines with the moſt ſoluble and moſt fluid part of the digeſted aliments, and forms the chyle with them. The other matter of the bile, compoſed of coagulated albumen, and of coloured, concreſcible, acrid, and bitter oil, is precipitated grumous, concrete, or diſpoſed to aſſume this ſtate with the undiſſolved, feculent, ſolid, ligneous, oſſeous, and undigeſted part

of the aliments, with which it is condenſed along the inteſtinal tube, which, by its contractions, expreſſes from it the chylous juice, ſucked in by the mouths of the abſorbent veſſels, and gradually dries the maſs deſtined to be diſcharged out of the body in the form of excrements.

44. Hence it appears, that the bile, being partly recrementitious, and partly excrementitious, effects, by a real chemical action, the firſt ſeparation of the alimentary maſs, which paſſes homogenous from the ſtomach; that it tinges the reſidue, which forms the excrements, with its coloured oil; that it is this alſo which gives them the greater part of their fetid ſmell, on which account, when obſtacles impede its paſſage into the duodenum, or when it does not flow from the liver, the excrements are without colour or fetor. It acts alſo as a ſtimulus, which irritates the ſides of the inteſtines; it excites their contraction, and thus cauſes the aliments to make their tranſit through this tube; at the ſame time it cauſes the flow and expulſion of the mucous and glairy juice of the inteſtines; its action is even purgative in ſome caſes: ſometimes being too ſtimulant or too irritating, it excites pains, pricking ſenſations, cholics, and gives riſe to abundant evacuations. Accordingly, the extract of the bile frequently ſupplies by art, the deficiency of the bile, and remedies, if prudently adminiſtered, that ſluggiſhneſs

ſluggiſhneſs of the inteſtines, which the want of this liquid neceſſarily produces.

45. As the oily, coloured, and acrid matter of the bile, being ſeparated from the ſoda, is thus diſcharged in the form of excrements, with the ſuperabundance, or the reſiduum of the food exhauſted more or leſs of its alimentary portion, it muſt be concluded that this kind of excretion is the means which nature employs for expelling from the body of animals this equally ſuperabundant oily ſubſtance. It was in this manner that Roux conceived the expulſion of what he believed to be the colouring part of the blood, which he conſidered as a matter that was acrid and pernicious when it had ſeveral times paſſed through the ſanguineous ducts, and to the retention of which he attributed the production of various diſeaſes. If this hypotheſis, which a more accurate knowledge of the blood renders leſs natural and leſs probable, ſhould be diſcovered to be really erroneous, we muſt always admit in this evacuation of the oily and irritating part of the bile, a courſe by which nature diſburthens the animal body of a ſuperhidrogenated principle, of a ſuperabundance of hidrogen; and this view, which I believe will be more and more confirmed by an attentive obſervation of the phenomena of reſpiration, and by the compariſon of the pulmonary affections with the ſtate of the hepatic and biliary ſyſtem, is even now a very advanced ſtep in the knowledge of one of

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of the chemical effects of vitality and deserves the most serious attention on the part of physicians. It will naturally accord with a multitude of facts which it is not my object to set forth in this place, but the announcing of which to those who are engaged with animal physics, will be sufficient to induce them to study it with attention.

SECTION VII.

Of the Medicinal and Economical Uses of the Bile.

46. PHYSICIANS have long employed the bile or gall of the bullock, inspissated to the consistence of an extract, and frequently under this name, as a tonic, stimulant, solvent remedy, and especially in order to promote digestion. They have supposed that whilst they supplied by this administration the deficiency of the bile in subjects with whom it is imperfectly secreted, they should restore to the functions of the primæ viæ a principle which they wanted for effecting the complete digestion of the aliments, for irritating or stimulating the intestinal tube, favouring the motion of the alimentary mass, and thus procuring almost natural evacuations, and remedying the evils to which the detention of the bile in its reservoirs gives

gives riſe. Experience has proved that a part of theſe views might in fact be fulfilled by the judicious uſe of inſpiſſated bile, and it is frequently made one of the ingredients of the medicines commonly employed in ſuch caſes; for the extract of bullock's bile is never adminiſtered alone, and without being aſſociated with other ſubſtances; it is mixed with extracts of aperient, ſolvent, inciſive, bitter plants; it is adminiſtered in electuaries, pills, boluſes. It ought always to be remembered that this extract is very deliqueſcent, that it becomes ſoft by expoſure to the air, that it cauſes the pills and boluſes, into the compoſition of which it enters, ſoon to loſe their conſiſtence, and that conſequently they muſt be prepared in ſmall quantity, and frequently renewed.

47. The notions reſpecting the properties of bile as a medicine, have, however, been much abuſed. Enthuſiaſtic, or credulous phyſicians, have not only attributed to it many more virtues than it actually poſſeſſes, and have employed it with profuſion in a multitude of different affections, in which its action may be detrimental, or in which its little effect has given occaſion to others to accuſe it of want of power or utility; but theſe exaggerated notions have been carried ſo far as to fancy ſpecific properties more or leſs abſurd in the bile of ſuch or ſuch an animal. In high eſtimation has been this bitter liquid procured from fiſhes, eſpecially from the eel, the carp, and the pike; and the preference

preference has been given to the one or the other in different pathological cafes. In fhort, fictions and abfurdities have been mixed with the fimple and fufficiently juft ideas which had firft been entertained refpecting the properties of bile in general; fo that in a manner the confidence has been diminifhed that might defervedly have been placed in the extract of bullock's bile, which, in fact, is the beft known, and the beft analyfed of thefe liquids. For it is to be remarked, that whilft admirable properties were afferted in the bile of the eel and of the carp, no chemical examination had been made of thofe fpecies of bile, nor had we endeavoured to acquire any real knowledge of their differences from the bile of the bullock.

48. The moft frequent and general ufe of the bullock's gall, is that to which it is applied by the fullers. The butchers fell it them by the name of *amer*; the gall-bladders of thefe animals are full of bile; and the fullers employ this liquid for taking out the fat and oil from the woollen ftuffs; and as the bile acts very well upon thofe fpots, which it caufes to difappear, it was long ago inferred that this liquid was of a faponaceous nature. In proportion as the oil is carried away by agitation and friction with the bile, this becomes frothy, efpecially with the firft portions of water, which are thrown upon the cloth in order to wafh it.

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Bile enters alſo into the compoſition of ſeveral colours; inſpiſſated into a ſolid or dry extract, when it is diluted in a little water, and affords a brown *biſtre* colour. It is for this purpoſe that the painters employ the biliary calculi of the ox, as I ſhall remark in the following article.

Article XXII.

Of the Biliary Calculi.

1. IT might ſeem very natural to treat of the nature of the biliary calculi in the hiſtory of the bile itſelf, ſince this liquor gives riſe to them, and ſince they appear to be of an analogous compoſition. Moſt medical authors who have ſpoken of them, have in fact regarded them merely as bile become concrete, and have thought that they were produced only by the too great inſpiſſation produced by a long continued detention of this liquid, either in the biliary pores, or in the gall-bladder. But as the analyſis of theſe concretions has preſented to me reſults conſiderably different from thoſe which the chemical treatment of the bile preſents, I have thought I ought to ſeparate the examination of their properties from that of this humour, in order that I might more effectually excite the attention of perſons of the art, and prove

ove that conclusions borrowed from analogy, and the mere probabilities respecting the nature of the bodies, almost all fall short of the truth, and ought never to be substituted for experiments, which alone are capable of discovering it.

2. Many authors have spoken of the biliary calculi, their physical properties, their differences from other animal concretions, and even of their chemical properties. Amongst the physicians, for they alone had in some measure the claim to interest themselves in the subject, on account of the relations which they have with the production of the symptoms, and with the cure of diseases, the following are particularly to be distinguished. Colombus found one in the confluent of the vena portæ, at the orifice of the corpus sti. ignatii. Glisson, Bianchi, Hoffman, have written very copiously upon these calculi. In 1749, Haller collected, in a programma, a great number of observations upon this subject. Walker, in his folio work on the concretions of the human body, which he improperly calls earthy, has described the biliary calculi with much accuracy, and distinguished them according to their structure, into classes, genera and species. Vicq d'Azyr, in the collection of the Society of Medicine for 1779, has described, with a number of details, nine remarkable species, and has also proposed a new classification of them. These two last anatomists have subjoined figures to their descriptions.

scriptions. As to the chemical inquiries upon these concretions, Haller in his history of the bile, has consigned the principal results obtained till in the year 1764, when his great physiological work was published. He has collected all the chemical facts observed till then by Hartman, Moseder, Hales, Taconi, Strohlen, Wieussens, Valisnieri, Grew, Boerhaave, Ludwig, Spielman. But all these authors have observed only some facts, they have examined only some insulated properties; none of them has made a connected or exact analysis of them. From the consideration of all these facts, we see that the biliary calculi are only partially soluble in water; that they are more soluble in alcohol; that they are light, oily, inflammable; that the caustic alkalies soften and dissolve them, as does the oil of turpentine, and even the fixed oils: that the nitric acid also dissolves them; that they become soft in the fire, like wax; that most of them are insipid or mild; that their centre, or nucleus is bitter: that in general they differ greatly from the urinary calculi. For the rest, all these properties have been announced as inconstant and variable.

3. Poulletier de la Salle first discovered, that when the biliary calculi were treated with hot alcohol, this liquid afterwards presented, by cooling, a number of brilliant, crystalline filaments, which he compared to the boracic acid, or to the flowers of benzoin, the nature of which he had not examined, not having been able

able to procure a ſufficient quantity of them for that purpoſe. I have learned from him that this ſingular matter, which had not been deſcribed before, was more ſoluble in hot than in cold alcohol, that it was ſeparated very quickly from it by cooling, that it exiſted in ſmall quantity in theſe concretions, and that it was not met with in the biliary calculi of the bullock. This animal is very much ſubject to concretions of this kind; they are found in its gall-bladder, eſpecially in the winter: the butchers extract them with care, and keep them for the painters, who make uſe of them in their deſigns. Van Swieten remarks, that in the ſpring, when the cattle eat the freſh herbage, the biliary calculi are diſſolved, and that it is on this account that none of them are found at this ſeaſon or in the ſummer. Hence he even concludes, as Haller alſo does, that the juices of herbs muſt be very good ſolvents of theſe concretions, and aſſerts that medical experience actually confirms this important notion derived from natural hiſtory.

4. In 1785, after having collected theſe facts from the mouth of Poulletier, the examination of the liver putrefied and dried in the air, in which I found the concreſcible oil I have ſpoken of, led me to ſuſpect that the cryſtalline laminæ of the biliary concretions of the human ſpecies might probably be of the ſame nature; and having treated in this view, all at once, a conſiderable quantity of biliary concretions

cretions which I kept in two dry gall-bladders that were filled with them, with hot alcohol in the proportion of fixteen parts to one of thefe concretions, I obferved that the yellow folution which I obtained, quickly depofited by cooling a remarkable quantity of brilliant filaments, the properties of which prefented to me a remarkable analogy with the oily matter of the liver dried in the air. When heated in a filver fpoon, thefe cryftals, which had a fat and unctuous feel, melted into a yellowifh oleagenous liquid, of a much lefs volume than their own, which fmell like wax, and which, after cooling broke into brilliant laminæ. I have fince afcertained that this matter does not melt, unlefs the temperature be raifed to nearly 90 degrees of the thermometer. Soda and cauftic pot-afh diffolved it completely, and brought it to the faponaceous ftate; the nitric acid likewife diffolved it, without ebullition or effervefcence, and formed with it a fpecies of liquid analogous to the oil of camphor. This laft property completed my conviction that this cryftalline matter of the biliary calculi has great analogies with fpermaceti; and it was from the comparative examination which I made of it, in different circumftances in which I have fince found it in animal matters become fatty by putrefaction, in the decompofed brain, &c. that I have named it in general adipocire, diftinguifhing it, however, into feveral varieties, according to its different degrees of fufibility, of folubility in alcohol,

fibres or not; in the ſecond, the calculi con poſed of a brilliant cryſtalline ſubſtance, wit or without a covering; and in the third, tl mixed biliary concretions, formed of yello biliary matter and cryſtalline ſubſtance. W ſee, that inſtead of following the form alon like Walker, Vicq d'Azyr began to perceive tl poſſibility of diſtinguiſhing the biliary calcu according to their nature, though he was ign rant, in 1779, what the cryſtalline ſubſtan was that was contained in them.

7. I now reckon ſix genera of biliary calculi

The firſt are the *bilious hepatic*, compoſe almoſt ſolely of thickened bile, depoſited i irregular clots in the texture of the liver itſel theſe are rare.

The ſecond are the *hepatic adipocirous;* the are found ſometimes in narrow laminæ, form ing ſolid points in the parenchyma of this vi cus; ſometimes they are prominent upon i ſurface, exhibiting ſmall white or yellowi tumors: they are very rare in this place; fre quently, perhaps, very ſmall ones of this kin are diſcharged, and run off with the biliou evacuations.

The third I call *cyſtic bilious:* theſe are con crete balls, or flakes of thickened bile, granu lated, irregular, very various in form and con ſiſtence, ſometimes friable, brown or reddiſh The calculi of the gall-bladder of the bullock which the painters uſe, are of this kind.

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The calculi of the fourth genus are the *cortical*, of the ſame nature with the preceding; they are only more denſe, and covered with a grey, or white ſmooth layer, well terminated with adipocire. They hold the ſecond rank with reſpect to their frequency. They are frequently found in great numbers in the gall-bladder; ſometimes even they exceed a hundred in number: they are then polygons, ſituated cloſe to each other like pieces of moſaic work, and diſtend the bladder more or leſs.

The fifth genus conſiſts of the *cyſtic adipocirous* calculi; they are white or grey, opaque without, or ſemi-tranſparent, granulated or ſmooth, covered with a cruſt of ſhort filaments, or without cruſt, formed of entire laminæ in their whole thickneſs. or of rays proceeding from the centre, and diverging to the circumference: very frequently they are ſingle, and they have then the form and ſize of pigeon's eggs. They are more rare than the preceding; they are moſt frequently found in women. At the termination of bilious diſeaſes, and almoſt always of chronic jaundice, irregular calculi or this ſort, ſomewhat dry, or ſolid, rather granulated than cryſtalline, ſoft, ſimilar to tallow, and yellowiſh, are diſcharged with the ſtools. This kind of adipocirous, or fatty evacuation, is much more frequent than has been believed, and may be obſerved in many ſubjects when their dejections are carefully examined at the termination of diſeaſes.

 Finally,

Finally, I refer to the ſixth genus the *mixed cyſtic*, or *adipo-bilious* calculi, which are mixtures of adipocire and thickened bile in various proportions: theſe are the moſt frequent of all, and like thoſe of the fourth genus, they are numerous: they are frequently found mixed with them; ſometimes brown, or of a deep green, or olive-colour, we ſee more or leſs eaſily in their interior, brilliant ſtreaks, or lamellæ, of a deep yellow colour, or only ſome micaceous points. When they are polyhedral, we obſerve upon their worn ſides, edges of broken cryſtalline laminæ.

8. All theſe calculi, being ſoluble in the cauſtic alkalies, in the ſolutions of ſoap, in the fixed and volatile oils, in alcohol, and partly even in ether, may be made to yield and diſappear, or ſoften, and even diſſolve by the uſe of theſe medicines when they are able to reach them. They ought to be attacked with theſe remedies, adminiſtered in a proper and judicious manner. Ether, combined with white of egg, is eſpecially very uſeful in allaying, at the ſame time, the ſpaſm and the contraction which theſe calculi produce in the gall-bladder. Frequently the ductus cyſticus, and the ductus choledochus dilate themſelves in an extreme manner, in order to afford them a paſſage. Theſe tubes, which are generally of the thickneſs of a ſmall quill, have ſometimes been found ſo much augmented in their diameter, as to ſuffer the finger to paſs eaſily from the duodenum to the baſe of

the liver; but moſt frequently their volume, or their number, occaſion the death of the patients.

Article XXIII.

Of the particular Animal Matters contained in the Inteſtines.

Section I.

Of the Inteſtinal Humour.

1. AFTER the gaſtric, pancreatic, and bilious juices, it is neceſſary to examine thoſe matters which are met with in the inteſtines, becauſe theſe viſcera follow after the ſtomach, and ſince they receive the liquids which muſt act upon them, and upon the matters which are contained in them, and theſe muſt likewiſe act upon theſe liquids already known. Five particular ſubſtances preſent themſelves to the obſerver in the continuity of the inteſtines. One of theſe ſubſtances derives its origin immediately from the ſides and the functions of this tube; this is the inteſtinal juice. The four others, though peculiar to this canal, proceed from the extraneous matters which paſs through it: theſe are the chyle, the excrements, the gaſes, and the inteſtinal calculi. Of theſe four matters, the two firſt are conſtant, and in the natural order;

thofe of the third genus, though very frequent, vary remarkably in their quantity and their nature, and abound only in a ftate of difeafe; and thofe of the fourth kind are always the product and the caufe of morbid affections. In the examination of thefe five fubftances, I fhall be obliged to avail myfelf of anatomical or medical obfervations, for want of chemical experiments; for thofe which have been made, either date from periods very much advanced for the art, or are only imperfect effays, upon which hardly any reliance can be placed: I fhall neverthelefs indicate the leaft inaccurate of thefe imperfect analyfes.

2. The fides of the inteftines are impregnated through their whole continuity with a humour which has been called the *inteftinal juice*, and which performs feveral important functions in this alimentary canal. Haller has reprefented this juice as a mixture of bile, of pancreatic juice, of the refidues of aliments, of the mucus, of the inteftinal pellicles, and of a humour exhaled by the arterial extremities. According to him, however, this laft is the moft abundant of all, and may be confidered as the true inteftinal liquor. It has, indeed, been impoffible hitherto to examine this liquor pure and infulated, becaufe no means are known for feparating it from the other humours which are mixed with it; but its quantity, which is fuperior to that of the others, juftifies the belief that the properties which have been obferved in the totality of

these liquids belong really to the inteſtinal humour, and may be conſidered as its true characters.

3. The ſurface, from which the inteſtinal humour exhales, preſents an immenſe organ, which Haller believes to be at leaſt equal, in its energy and in its product, to that of the whole ſurface of the ſkin. The ſame anatomiſt obſerves, that the arteries, the extremities of which pour out this humour, equal, at leaſt, in the ſum of their diameter, that of the two renal arteries; ſo that the maſs of the liquid exhaled, were it eſtimated only according to the quantity of ſurface which furniſhes it, would appear to approach remarkably to that which is ſecreted by the kidneys, as this approaches to that which is evaporated by the ſkin. Haller, according to calculations founded upon meaſurements of the length and the internal ſurface of the inteſtines, goes even ſo far as to believe that about eight pounds of inteſtinal humour is ſeparated in twenty-four hours; which is twice as much as is diſcharged by the ſkin: it is to this that he attributes the immenſe quantities of aqueous liquids in ſome diarhoeas, and at certain periods of dropſies. But theſe laſt-mentioned circumſtances differ too much from thoſe of the healthy ſtate, for it to be poſſible to conclude any thing from them for ordinary caſes; and as to the calculation of the learned Haller it is too little ſupported by accurate baſes, to induce us to believe that the proportion

proportion of the inteſtinal liquid is twice as much as that of the tranſpiration. There is merely reaſon to believe that it is not much different from that of this inſenſible evaporation.

4. All the phyſiologiſts, who have ſpoken of the inteſtinal humour, have believed it to be of the ſame nature with that which is ſeparated upon the interior ſurfaces of the pleura, of the pericardium; and to this compariſon they have confined themſelves. Some obſervations, both after the ſtools, and upon the dejections, which have been conſidered as proceeding from the greater abundance of this humour, have cauſed them to conſider it as viſcous, ropy, thick, glairy, or mucous. Pechlin and Brunner have found it coagulable by fire and by the acids. It has been obſerved concrete, and formed into laminæ and fibres, or in thick clots, lining the ſides of the inteſtines, and adhering to them more or leſs ſtrongly, ſo that it was even difficult to detach it from them. It has been found altered and fetid, ſo often as to render it probable that it is very putrefiable; but this property may be attributed as much to its mixture as to the pure inteſtinal humour, ſince no chemiſt has examined it alone. Its uſes are, according to the phyſiologiſts, and Haller himſelf, to ſheathe and cover the nerves, in order to defend them againſt the acrid ſubſtances which ſometimes paſs through the inteſtinal canal, to prevent the ſides of the inteſ-

tines

tines from drying, adhering to each other, or to the extraneous ſubſtances which paſs through them, to oblund the acrimony of the aliments, to dilute the chimous maſs, and to connect together the excrementitious matter, to furniſh a part of the lymphatic juice which conſtitutes the chyle, and to be ſucked in by the abſorbent veſſels.

SECTION II.

Of the Chyle.

5. THE chyle is formed of part of the aliments melted and diſſolved by the gaſtric juice itſelf, of a portion of the bile and pancreatic juice, and of the inteſtinal humour abſorbed with it by the chylous veſſels, which do not differ from the lymphalic abſorbents. It is known that it paſſes pretty rapidly through theſe veſſels diſſeminated in great numbers upon the inteſtines, opening into their cavity, traverſing the meſentery, anaſtomoſing with one another, uniting and becoming leſs numerous the more remote, they are from the inteſtinal tube; forming at leaſt three orders or ſeries of veſſels, ſeparated by conglobate meſenteric glands, from the inteſtines to the lumbar receptacle and the thoracic duct, where they unite, and thus convey the chyle into this duct, which

which is sometimes double, and most frequently opens into the right subclavian vein, very near the heart. Haller, according to the comparison of a number of facts, estimates that the chyle is separated from the aliments between two and five hours after the repast, and that six hours are almost always sufficient for extracting from the alimentary mass all the chylous substance which it is able to furnish.

6. No chemist has yet examined this humour, and we do not know of any series of experiments indicating that its analysis has even been attempted. It may therefore be asserted, that we are as yet almost entirely ignorant of its nature. Some experiments have, however, been attempted, and observations made by able anatomists and chemists. Haller has collected their principal and most important results in his great work on physiology. I shall here enunciate them briefly, taking care to quote the sources whence they have been taken, and the authors to whom we are indebted for them. I shall afterwards deduce some consequences, and show that we have really no satisfactory notion concerning this liquor, the first origin of the blood, and of all the materials, both in the liquids and in the solids, of which the bodies of man and of animals is composed.

7. Lower, Michelotti, Slare, and Brunner, have found the chyle of a white colour,

with

with a ſweet or ſomewhat ſaline taſte, on which account they have compared it to milk. Lister has ſeen it light, ſwimming like an oily liquor upon the blood and the ſerum. Wepfer has obſerved that a kind of cream was formed at its ſurface. Bowden, Pecquet, Barthollin, Leidenfroſt, Monro, have deſcribed its coagulation, which they had obſerved both in its veſſels and round the ruptured thoracic duct. Bohn, Berger, and Aſch, have deſcribed butyraceous globules in it, ſwimming upon an aqueous liquor. The ſame authors have admitted a caſeous matter which is precipitated from it, which they conſidered as more earthy than the reſt of the principles of the animal humours, and in which they placed the ſource of the calculous concretions of the chyle, found in the receptacle itſelf by Schers, who has deſcribed them in a particular diſſertation, in the thoracic duct by Le Dran and Bohn, and in the lacteal veſſels by Goelike. It is from theſe different aſſertions, made by enlightened authors, that the chyle has generally been compared to milk, and that ſome have even gone ſo far as to ſeek the cauſes and the differences of diſeaſes in the ſerous, the caſeous and the butyraceous matter of this humour, as Aſtrue has done in his pathology.

8. Bohn and Bartholin have alſo obſerved an aceſcent property, and even an acid ready formed in the chyle; Birch even aſſerts that he has ſeen it redden the tincture of turnſole, though

though Viridet denies the existence of this properly in it; Kulmus, affirms that he has found it prefent after it had been heated. It has been found that the aliments have an influence upon its characters and properties. Indigo mixed with the food, and received into the ftomach, gave it a blue colour in the experiments made by Martin Lifter, by Mufgrave, and confirmed by the illuftrious Haller. They have equally fucceeded with Gould and Felix, who have varied them in different ways. Mattei fays, he has feen chyle turned red by beet-root. Viridet mentions its having been turned yellow by the yolk of egg. Haller, however, has never been able to difcern either of thefe tinges. Several obfervers fpeak of greenifh chyle in the animals that feed upon herbage. Mingini has convinced himfelf by experiments, that iron mixed with the aliments is not found again in the chyle, or that at leaft it cannot be rendered fenfible in it by the gall-nut. But the ftate of phofphate of iron, in which it is probably introduced into the chyle, does not permit it to be eafily coloured by this re-agent.

9. Thefe are the whole of the facts that have hitherto been collected refpecting the chyle which have a reference to its chemical properties; but they afford a very imperfect outline of what it would be neceffary to know refpecting its properties. We fhall be able to judge of this imperfection of the fcience with refpect to this fubject, from what I am about to fay

refpecting

respecting the experiments that have been latterly tried in the School of Medicine of Paris, which the author, my colleague Hallé, has communicated to me. Chyle was collected by opening the thoracic duct of several dogs, five or six hours after having made them eat a cake of milk, flesh, and crumb of bread, with which blue, red, or black colouring matters had been mixed. The dilated thoracic duct was tied in the thorax, and an orifice was made below the ligature. By this means nearly 100 grammes of chyle were obtained, which were made to flow into glass cups. In no case was it found tinged with the colouring matter that had been mixed with the aliments. A very short time after this liquor had been exposed to the air, it coagulated, or rather it assumed the gelatinous form, and presented a sort of curd adhering by its margins to the sides of the cup. There was, under this apparently gelatinous part, a liquid portion, which did not rise to the top till after the curd had detached itself from the sides of the cup. The chyle was thus divided into two parts: the one liquid, of the colour of milk, very thin; the other solid, in a single piece, the parts of which were connected together by a real tenacity, similar to that of the coat which is formed at the surface of the blood in uninflammatory catarrhal affections. This coagulated mass has the semi-transparency of the opal; it has a light red tinge as well at its surface as in the sub-

stance

ſtance and in the portion expoſed to the air; this tinge however is more intenſe at the points of contact with the air. It is cut by a neat ſection with the ſciſſors, and has no reſemblance with the caſeous part of milk.

SECTION III.

Of the Excrements.

10. THE excrements are formed in man only in the large inteſtines; the alimentary maſs has not yet their character and fetor at the end of the ileun, and only begins to aſſume it in the cœcum. In children they are more ſoft and more chylous than in the adult. Their ſoftneſs and liquidity in adults, indicates a weak digeſtion. Their too great hardneſs and dryneſs, which generally cauſes them to aſſume the form of ſeparate balls, ſometimes goes ſo far as to retain them for a long time in the large inteſtines, where they accumulate and conſtitute maſſes which may become dangerous. Their moſt common form is given them by the ſplinter ſituated at the extremity of the rectum; and the ſtructure of this part determines the figures which diſtinguiſh them, as is well known, in the different ſpecies of animals. The fetid ſmell which characterizes them in man and is peculiar to each individual, though it is of the ſame deſcription in thoſe of the ſame ſpecies of animals, is attributed, like their colour, to the

the portion of bile that is combined with them, which is confidered as having already undergone with the feculent matter, a commencement of putrefaction. When their colour is brown, it depends upon the ftay which they have made in the inteftines and this colour is commonly joined with a greater degree of folidity. A depraved appetite or an uncommon courage have afcertained that the tafte of the excrements is faint or fweetifh, and fometimes even ftrongly acid. Their weight is between 128 and 160 grammes in adults; it is nearly twice as much with thofe who live upon vegetable food. We may almoft always obferve in them very diftinguifhable remains and fragments of folid parts of the aliments, tendinous, ligamentous fibres, barks, and entire feeds : the latter, covered with their tunic, ftill preferve in them their property of germinating.

11. No true chemical inveftigation has yet been undertaken which might be confidered as an analyfis of the excrements. The experiments or obfervations made by phyficians upon thefe difcharges, and fome experiments tried with alchemical views which have been much exercifed upon this fubftance, are the only materials from whence we can derive even vague and uncertain notions. Homberg defcribed, in 1711, fome phenomena which he had occafion to obferve in courageoufly purfuing feveral alchemical experiments by which he hoped to fucceed in fixing mercury; for thefe notions and hopes

ftill

ftill prevailed during the firft years of the eighteenth century. Roth, Grew, Lemery, Macquer, Barchufen, Brownrigg, Pinelli have alfo made fome experiments upon the human excrements; and it is only from thefe ftill very feeble fources that we can derive fome notions refpecting their nature. Grew has feen the excrements effervefce with the nitric acid, become black, and exhale an odorous oily emanation, inflammable by the concentrated fulphuric acid. Homberg extracted from them by diftillation on the water-bath, a clear water which formed $\frac{9}{10}$ of their weight and a coloured empyreumatic oil. He could not obtain a clear oil from them till after having fuffered them to ferment, and by putting the diftilled water which he had extracted from them together with the refidue of thefe excrements thus dried. Roth fays he obtained from them a turbid and milky water of an infupportable fmell, and he remarks that the refiduum of this firft diftillation was oily. Lemery has defcribed two fpecies of oil furnifhed by this diftillation, the one yellowifh and the other highly empyreumatic; he announces alfo a volatile falt or ammoniacal carbonate forming $\frac{1}{15}$ of the weight of the excrements. Browarigg and Pinelli agree with Lemery in admitting the prefence of muriate of fóda in the refiduum. Barchufen afferts that there is very little falt in that of the human excrements. Their coal is very inflammable: it is known that it was with this coal, treated by alum, that Homberg, for

3 the

the first time prepared the Pyrophorus, and that he then believed that these matters were indispensably necessary to its production. Macquer has remarked upon the subject of the distillation of the excrements, that they afforded no ammonia upon the first impression of the fire, as putrefied matters would do.

12. The excrements of man and of different animals have also been examined by means of water; though indeed this kind of analysis has as yet been made with little accuracy. Some chemists, especially Homberg, Roth, and Cuntad, have extracted by this process a salt which they have said to be nitrous, detonating, forming crystals with six angles, mild and fusible. Some have even spoken of two different salts afforded by this lixivium. It has been remarked that the excrements of cows, sheep and goats give an acid character to water. This property has been particularly observed in the dung of the pigeon, to which some have even attributed an almost caustic activity in vegetation when mixed with the earth. We have descriptions of inflammable vapours disengaged from accumulations of excrements, from privies, and the explosions which they have produced; the fetid gases which have exhaled from these matters, some of which are dangerous and extremely mephitic; and the sulphur which sublimes upon the walls, upon the vaults, and especially upon the surface of their key-stones. Observations made on a large scale on remains of excrements that

that had continued for a long time heaped together have ſhown that the ſtones and the maſonry which they covered and in the midſt of which they had putrefied, were impregnated with ſulphur cryſtallized or depoſited in the ſtate of powder. Macquer and Nollet have given an account of plates of ſilver which had acquired a gold colour by remaining in the ſewers of privies, and were converted into ſulphate of ſilver.

13. Citizen Vauquelin is, as far as I know, the only modern chemiſt who has made ſome late experiments upon the excrements. He has convinced himſelf that they are conſtantly acid; that they redden the blue vegetable colours, that they are eſpecially very ſuſceptible of fermentation; that they at firſt acquire by this movement a more acid chracter than that which they naturally have; that ammonia ſoon ſucceeds this acidity, and continues till the complete deſtruction of theſe matters.

The ſame chemiſt has alſo made ſome conſiderably connected reſearches upon the dung of the pigeon and of the pullet. The firſt, which is very ſour, ferments as ſoon as it is ſteeped in water. It appears naturally to contain a peculiar acid: this acid continues to be formed by the fermentation which takes place in it, and is ſucceeded, after ſome time, by ammonia, which is abundantly developed towards the termination of this ſpontaneous movement.

As

As to the dung of the pullet, the object of the experiments to which he subjected it, was to compare it, in its quantity and in its nature, with the aliments given to this animal and with the egg-shell which is formed, as is well known, in the lowest part of the canal which the excrements pass through. He has therefore given the results of the analysis of the egg-shells before these relative to the pullets' dung. The following is a sketch of his comparative inquiry upon these two matters.

14. The shells of eggs weigh upon an average about 5 grammes. Calcined to blackness, they lose about $\frac{1}{5}$ or 0,2, of their weight. After their calcination they afford, during their solution in nitric acid, carbonic acid gas mixed with sulphurated hidrogen gas.

A thousand parts of egg-shells are composed of:

1, Carbonate of lime	-	0,896.
2, Phosphate of lime	-	0,057.
3, Animal gluten and moisture		0,047.

Eggs weigh upon an average about 58 grammes; thus a hen that had laid 130 eggs in six months, would have produced in this space of time about 7 $\frac{1}{2}$ kilo-grammes of matter necessary for this formation.

15. The dung of the hen calcined gave 5.2 grammes of residuum, that of the cock only 3 grammes.

The 5.2 grammes of hens' dung, burnt and treated by the nitric acid, left 2,33 of insolu-

ble residuum; the 3 grammes of cocks' dung left 1,06 grammes.

The ashes of hens' dung, dissolved in the nitric acid and precipitated by ammonia, afforded 2 grammes of phosphate of lime, and those of cocks' dung afforded 1,17 grammes.

The liquor from which the phosphate of lime had been precipitated from the hens' excrements, mixed with potash, gave 0,185 grammes of carbonate of lime, and that of the cocks' excrements, 0,265 grammes.

Though there remains more calcareous earth in the excrements of the hen that lays eggs, than in those of the cock, this fact is explained by the larger quantity of nutriment which the hens takes at this period, and the more complete digestion of the nutritive substance contained in these aliments.

The excrements of the hen that does not lay eggs, and those of the cock are covered and mixed with a white matter, which is not found, at least not in so large quantity, in those of the hen that lays. This white matter is a kind of albumen coagulated and dried in the air.

Thus it appears that it is this substance which serves to connect together the calcareous parts of the egg-shell, and to give it, in some measure the flexibility which it possesses at the moment when it is laid.

16. Oats, which were the food of the hen upon which this experiment was performed, gave by incineration about $\frac{1}{100}$ of residuum

These

Thefe afhes, mixed with nitric acid, diffolved in part without effervefcence; the undiffolved portion formed 0,018; the diffolved portion was phofphate of lime, and amounted to 0,005

The portion not diffolved by the nitric acid was pure filex.

Hence it follows that oats yield 0,031 of afhes; that thefe afhes are compofed of 0,393 of phofphate of lime and 0,607 of filex.

In the fpace of ten days a hen eat 484 grammes of oats, and laid 10 eggs.

The excrements which fhe difcharged during this time having been burnt, yielded 39 grammes of afhes, which gave by analyfis, 1,77 grammes of phofphate of lime; 22,6 grammes of carbonate of lime; 38,5 grammes of filiceous refiduum.

A formation of lime and of phofphoric acid has taken place in the body of the hen; for 1. the excrements of the hen afforded 2,6 grammes of carbonate of lime, and the oats yield none 2. again, the hen laid during this period 4 eggs, the fhells of which weighed together about 20 grammes; which forms a fum of 22,6 grammes; and 3. the oats alfo afforded only about 6 grammes of phofphate of lime, and the excrements of the hen which were formed from them furnifhed nearly 12 grammes.

When we compare the quantity of filex found in the oats and that of the excrements of the hen that was fed upon them, we find 9,34 for the oats and only 8 in the excrements which

proceeded from them: there is therefore a deficiency of 1,3 grammes.

Muſt we thence conclude that it is this ſilex that has ſerved to furniſh the exceſs of lime? For this purpoſe it would be neceſſary that it ſhould abſorb nearly five times its weight of an unknown principle.

17. It reſults from all theſe facts, which are the only ones that yet exiſt in the hiſtory of the art, that there is no collective whole, no ſyſtem of analyſis of the excrements; though we may find in theſe reſearches an uſeful application to animal phyſics. We ſee however now that this kind of inquiry may throw great light upon the digeſtion of the aliments, and that it is of importance to undertake it immediately, ſince the means are now both more numerous and more certain. A comparative examination of the vegetable or animal aliments, before thoſe aliments are given to an animal, of theſe ſame aliments digeſted in the ſtomach and in the inteſtines; finally, of theſe matters when they have become excremental, either whilſt ſtill contained in the large inteſtines, or after they have been diſcharged from this canal, muſt lead to an exact determination of what happens in the charges affected by digeſtion, how much matter is abſorbed by the chylous veſſels, in what proportion it is diſcharged, and eſpecially the different ſtates which it acquires at different periods of this function. All this belongs to the pro-

vince

vince of chemiſtry, and what is wanting to phyſiology muſt be furniſhed by this ſcience.

BODLEIAN

Section IV.

Of the Inteſtinal Gaſes.

18. THE inteſtinal tube is frequently diſtended by elaſtic fluids, which are diſcharged with or without noiſe from its extremity, and conſtantly accompany the digeſtion of the aliments. Their diſengagement, which varies much in proportion, both according to the aliments, and that of liquids diffuſed in this canal, as alſo according to the ſtate itſelf of its interior ſurface, ſeems to depend upon a fermentation of the alimentary maſs, and it is to this movement that their production is commonly attributed. It is however known at preſent, that there may take place in the aliments chemical changes adopted to extricate elaſtic fluids, without the exiſtence of a real effervefcence, which, being admitted by the ſchool of Sylvius, might have been conſidered as the ſource of theſe inteſtinal gaſes. In order to underſtand this gaſeous diſengagement, it is ſufficient to acknowledge a chemical modification of the alimentary maſs, mixed with the liquids exiſting in the inteſtines; a modification ſimilar, for example, to that which is produced

duced by the action of the nitric acid, when converting these substances into oxalic acid, into adipocirous matter, and into bitter yellow substance, it dissolves a part of them into azotic gas, carbonic acid gas, and Prussic acid.

19. In whatever manner this formation of gas is effected, and to whatever cause it is to be ascribed, it is known that it takes place more frequently and more abundantly in the large intestines than in the smaller; that it sometimes produces considerable distensions; that the colon is especially attacked with this disorder; that it is frequently contracted at the two extremities of the dilated part, the volume of which then exceeds several times that which it naturally has; that in the most ordinary cases, the true and peristaltic force of the intestines re-acts upon these elastic fluids and propels them to the anus through which they escape out of the body. I have already remarked that there is no digestion in which such gases are not formed and disengaged. We have multiplied proofs that the farinaceous vegetables, especially the leguminous seeds, possess, in a more especial manner than the other kinds of aliments, the property of producing elastic fluids; and it is on this account that they are called *flatulent aliments*. As these substances are subject more than others to enter more easily and strongly into fermentation, it is evident that it is by the spontaneous change which they

they experience in the primæ viæ, that this difengagement is produced.

20. Formerly nothing was ftated concerning the nature of the elaftic fluids produced by digeftion; they were all confounded with the air, and this was the only affertion refpecting their intimate properties that was to be found in all the works of phyfiology. Their fetor had however been infifted upon, and it was vaguely attributed to putrid matters which the air carried along with it. It had alfo been obferved in fome circumftances that this pretended air was fufceptible of inflaming, and the relation which prefented itfelf under this point of view, between this inteftinal emanation and the combuftible fluid difengaged from the feculent matter putrefying in privics had alfo been noticed. It is only fince the new difcoveries refpecting the difference of the elaftic fluids, the properties which characterize each fpecies in particular, and efpecially the means of feparating them, and determining their nature, that we have been able to know thefe bodies better and to afcertain that they are not atmofpheric air.

21. In the gafes iffuing out of the inteftines carbonic acid gas has been found in great abundance; and it generally conftitutes the greateft part of fuch of thefe fluids as are without fmell; carbonated and even fúlphurated hidrogen gas, though the latter is rather rare: thefe two laft are more or lefs fetid! and burn

burn with a blue flame at the approach of a lighted taper. Thefe gafes are eafily collected above the bath when the body is immerfed in water: it has been pretended for fome time that fome of thefe gafes, particularly carbonic acid gas, iffued alfo through the pores of the fkin; but this affertion ftill wants confirmation. It has been found by obfervations, which now are confiderably numerous, that in ordinary cafes, it is carbonic acid that is difengaged in eafy and quick digeftion, and that the indigeftions accompanied with uneafy fenfations and extraordinary motions pretty conftantly give rife to carbonated or fulphurated hidrogen gas. Thus it happens, that when the inteftine of a horfe or of a bullock is punctured with a trocar, as is ufually done in order to relieve the violent pains which arife from its dilatation, the gas which efcapes in confequence of this operation fuddenly inflames upon the approach of a candle. It has alfo been believed that there was azotic gas amongft the elaftic fluids of the inteftines; but as it is certain that the atmofpheric air penetrates this organ, and that fome of it conftantly paffes with the alimentary bolus, there is reafon to believe that it is the fame with this gas as with the portion of oxigen gas which is found in them at the fame time. Both proceed from the quantity of air contained in the aliments fwallowed down with them, and difengaged by the heat of the inteftinal tube.

SECTION

Section V.

Of the Concretions or the Calculi of the Inteftines.

22. SOMETIMES concretions or kinds of calculi are formed in the inteftines of man: their fides have been found lined or covered with a kind of cruft fufficiently hard to have been called *ftony*, and more frequently bodies that have paffed flowly through their canal or remained for a long time in it, inveloped or incrufted with folid or cryftalline layers. A mufket-ball, a bone, the kernel of a fruit, a piece of wood, fmall fhot, calculi of the gall-bladder, have feveral times become center, round which layers of folid fubftance have collected in the inteftines. In the animals thefe formations of inteftinal calculi are ftill more frequent; and the horfe is extremely fubject to this kind of concretion, which frequently acquires a very confiderable fize and weight. Befides thofe nucli of calculi foreign to the inteftines, there are fome alfo which are peculiar to them and which are formed without requiring thefe accidental bodies. We muft not here omit to mention thofe maffes of agglutinated hairs, felted and pafted together with inteftinal juice, which gives them their adhefion and folidity, nor the ftercoral

ſtercoral calculi proceeding from excremental matter retained and condenſed in ſome of the folds of the great inteſtines.

23. Thus ſeveral matters, eſpecially the bile, the pancreatic juice, the inteſtinal juice itſelf, the remains of aliments, may give riſe to calculi which muſt differ from each other by their colour, their texture, their denſity, their form and eſpecially their nature. Chemical analyſis eaſily enables us to diſtinguiſh them from each other, and though we have not yet had a conſecutive ſeries of reſearches upon this ſubject, it is not neceſſary to enable us to know how to determine the compoſition of each ſpecies of theſe calculi. I have indicated in the hiſtory of the genus and of the ſpecies of phoſphates, that of magneſia and ammonia as forming the ſpecies of inteſtinal calculus of the horſe, which is called though improperly, the *Hippholitha*. I am inclined to believe that the pancreatic humour and the inteſtinal juice are the principal ſources of theſe concretions, eſpecially when they are formed upon an extraneous body which ſerves them as a nucleus.

ARTICLE XXIV.

Of ſome Abdominal Animal Matters peculiar to the Fœtus.

1. AMONG the peculiarities of ſtructure and of functions which diſtinguiſh the fœtus from the adult, there exiſts three very remarkable differences relative to the abdomen. The fœtus in utero is immerſed in a liquid incloſed in the amnios, which is called the *liquor amnii*; the ſuperenal glands, very much developed, contain a liquor which fills their cavity; finally, the inteſtines of the fœtus preſent a liquid of a dark colour, which holds the place of the excrements, and which is called the *meconuim*. Theſe three humours, which have intimate and immediate relations with the life of the fœtus, as nothing ſimilar to them is found even in the adult nor even in the infant ſome days or ſome months after its birth, merit the particular attention of the phyſiologiſt and the phyſician; they preſent to the firſt ſeveral problems relative to animal phyſics of great importance to be reſolved, and to the ſecond phenomena uſeful for the underſtanding of ſeveral diſeaſes though chemiſtry has as yet afforded little light reſpecting each of them, it furniſhes however ſome facts relative to their nature which ought not

not to be neglected. It may besides lead to discoveries the possibility of which we ought not to omit to mention, or to indicate their importance, and invite physicians to occupy themselves with them.

Section I.

Of the Liquor amnii.

2. THE amnios, the second membrane peculiar to the fœtus, situated in the uterus below the chorion, much thinner than it, forms a kind of bag or sack, well closed at every part, the cavity of which contains the fœtus immersed in a particular liquid. It is, if I may use the expression, the egg shell of the viviparous animals; it is thin and transparent; it is only with difficulty that we can perceive sanguineous vessels, in very small number and very minute, distributed in it. It is also very difficult to discern lymphatic vessels, of which however it is probable that its texture is formed, since it has besides all the characters, and performs the functions of a serous membrane. There is reason to believe that the membrane placed between the chorion and the amnios, which contains many vessels, in the source which furnishes the secretion of the liquor amnii. At the place where the umbilical chord, proceeding from the

4 placenta,

placenta, penetrates the amnios, it does not perforate it, but pushes it in some measure before it, and receives from it a doubling or kind of very thin sheath, which accompanies it to the navel of the fœtus and quitting it at this region, confound itself with the integuments of the abdomen : thus the liquor of the amnios is contained and inclosed in a cavity comprehended between the internal surface of this membrane and the body of the fœtus; it even deposits upon the skin of the latter a mucous or flaky covering, more or less abundant, thick, whitish or yellowish, which it brings with it into the world, and from which it is generally freed by washing it off with warm water or wine.

3. The liquor of the amnios varies in quantity not only in the different individuals, the source infinite and inappreciable differences, but also in a constant manner at different periods of pregnancy and of the age of the fœtus. In the first periods of pregnancy, it is much more abundant, comparatively with the weight of the fœtus, and gradually diminishes till the period of delivery. Women however sometimes discharge a considerable quantity of it before delivery; sometimes a large quantity flows off after the birth of the infant. It has been pretended that the liquor amnii is at first thick, sweet and mucous, and that it afterwards becomes limpid and acrid ; but it is possible that the effect of a morbid circumstance has here been taken for the natural state, and that such a change is effected

fected only by a pathological alteration. Some authors have announced in the water of the amnios a ſmell and colour ſimilar to thoſe of the urine: it is true that ſeveral anatomiſts have pretended that it proceeds from the urinary bladder of the fœtus, whilſt others have conſidered it as the product of its ſweat, its expectorations, or its digeſtion; whereas it is very natural to believe that it has the ſame ſource as the liquid of all the ſerous membranes; that it is a lymphatic exhalation and that it flows through the pores themſelves of the ſides of the amnios. No part of phyſiology has been the ſource of more romantic hypotheſes than the origin and uſe of this liquid. In the great number of theories for explaining both the one and the other, we ſcarcely find a few facts reſpecting the properties and the nature of the water of the amnios; and theſe facts are moſt frequently contradictory.

4. The liquor of the amnios is tranſparent, a little viſcous and gluey to the touch, of a ſaline taſte, ſlightly ſweetiſh, ſo that it has been compared to whey by ſome authors, whilſt others have aſſerted its ſimilarity to urine. It is heavier than water, and firſt falls to the bottom of this liquid before it mixes with it. This liquid turns the ſyrup of violets green. Expoſed to the fire it coagulates, not into a maſs, but affords many clots or flakes that are ſoon depoſited. The acids and alcohol produce the ſame effect upon the liquor of the amnios; they coagulate it

it and produce in it a flaky precipitate. It is aſſerted that the coagulable property diſappears in this liquor when it has become altered, when it has acquired an acrimony which ſometimes in ſuch as to corrode the hands of the accoucheur. The alkaline leys and lime water alſo produce a precipitate in this liquor, on account of the phoſporic ſalts which it holds in ſolution ; the oxalic acid proves the preſence of the phoſphate of lime in it. The nitrates of mercury, of lead and of ſilver, alſo precipitate the liquor of the amnios, and the precipitate is a mixture of metallic muriate and phoſphate. Tannin alſo forms in it a very abundant fawn-coloured precipitate.

5. Though the experiments of which I have juſt ſet forth the reſult, according to the facts collected by Haller in the works of Berbatus, of Ruyſch, of Fanton, of Roederer, of Mauricean, of Denys, of Tauvry, of Longfield, &c. are not ſufficient to conſtitute a true analyſis of the liquor of the amnios ; they however exhibit very marked characters of an albuminous liquid ; they ſhow its ſimilarity with the liquid which is exhaled in the cavities, and which belongs to the ſerous membranes ; ſo that it is natural to compare it, as the moſt accurate phyſiologiſts have done, with the liquor of the pericardium, of the peritonæum and of all the lymphatico-ſerous membranes. Beſides it follows their conditions ; it ſhows their properties by its variable proportion, which is ſome-

ſometimes ſuch, that it reſembles or even conſtitutes a dropſy, by the filaments and flakes which it depoſits, and which adhere to the ſkin, as frequently takes place between the ſerous membranes and the ſurface of the viſcera which they cover. This well marked analogy alone ought to induce us to believe that it is with the ſource of the liquor of the amnios as with that which lubricates all the membraneous cavities; that it is furniſhed by the arterial extremities proceeding either from the chorion, or from the cellular and vaſcular membrane ſituated in the middle between the chorion and the amnios.

6. An analyſis of the liquor amnii of woman, made lately by Citizens Vauquelin and Buniver, Phyſician at Turin, confirms ſtill more the firſt reſult of the ancient experiments. They have found it to have a ſweetiſh and faint ſmell, like the ſpermatic liquor, a ſaline taſte, a milky white colour, rendered turbid by flakes reſembling cheeſe, which being retained upon a filtre, reſembled the matter depoſited upon the folds of the ſkin of the fœtus. Its ſpecific gravity was 1,004; it became frothy like gum-water by agitation, turned the ſyrup of violets green, and yet reddened the tincture of turnſole; pot-aſh precipitated gelatiniform flakes from it: the acids clarified it when it had become turbid by fermentation; alcohol ſeparated from it a matter which became brittle by deſſiccation, like albumen. The gall-nut formed in it an abundant browniſh depoſition, as gelatin does.

Heated

Heated after its filtration, it became milky, without undergoing coagulation; it exhaled the ſmell of hard-boiled white of egg; it preſented at its ſurface a pellicle which broke and was renewed; it gave a reſiduum weighing 0,012 of the liquor: this reſiduum waſhed with cold water afforded cubes of muriate of ſoda, and cryſtals of carbonate of ſoda; the animal matter exhaled upon the coals, a fetid ammoniacal odour, like horn; it left very little phoſphate of lime. Incloſed in a bottle, it fermented, became turbid, and grew white, diffuſing ammonia, without affording either odour or gas. The authors of this analyſis have concluded that the water of the amnios is a ſolution very little charged with albumen, by means of a light and volatile acid containing muriate and carbonate of ſoda, and a ſmall quantity of gelatin and of phoſphate of lime.

7. The uſes of the liquor of the amnios are manifeſtly to maintain the flexibility of the members of the fœtus and of its coverings, to prevent adheſion between theſe parts, to guard the fœtus againſt compreſſion, to facilitate its paſſage by gradually dilating the neck of the womb, by ſoftening and lubricating the parts through which it muſt paſs: the diſcharge of this liquor generally indicates that delivery is at hand. As to the opinion of phyſiologiſts who add to theſe generally acknowledged uſes, that of nouriſhing the fœtus, though it cannot be denied that the liquor of the amnios may

perform this function, since it is generally sweet and albumious; it is however much more probable that nature has not destined it for the nourishment of the fœtus, because it commonly has its mouth well closed, and the base of the tongue applied strongly against the velum palati; because it cannot perform real diglutition; and it is not proved that there is any liquor in its stomach similar to that of the amnios; and finally, because the small quantity of meconium contained in its intestines does not correspond with the mass of aliments which it might take in this way. The cases of the umbilical chord being withered, tied or destroyed, which seem to have authorized some authors to admit the opinion of the nourishment derived by the fœtus from the liquor of the amnios, cannot be favourable to this opinion, when their inaccuracy is examined: and those in which the fœtus has perished for want of this chord, or on account of its defects, are much more numerous and comparatively stronger. If, as some anatomists assert, there sometimes presents itself in the stomach of the fœtus a liquor which cannot be mistaken for any other than that of the amnios; this circumstance is so rare, and is besides involved in so many difficulties, that it ought to be considered as an extraordinary occurrence, actually contrary to nature, and in no respect favourable to the opinion which I endeavour to disprove.

8. Citi-

8. Citizens Vauquelin and Buniva, in the courfe of their inquiries concerning the water of the amnios of woman, have examined the matter depofited upon the fkin of the fœtus, efpecially upon its groins, arm-pits and the hairy fcalp. This cafeiform fubftance is white, fhining, foft to the touch, refembling new-made foap; it is infoluble in water, though it forms a froth with it when boiling. It is not attacked by alcohol or the oils. The alkalies diffolve it in part and convert it into a kind of foap; there remains a fmall quantity of undiffolved mucilage. Placed upon the coals, it decripitates and flies about like a falt; it dries, becomes black, exhales an oily empyreumatic vapour, and leaves an abundant coal difficult to be burned; treated in a crucible, this matter decrepitates, and exudes an oil from all its points, becomes horny, inflames, and affords a coal which is reduced into an effervefcent cinder, compofed of carbonate of foda and phofphate of lime. This analyfis exhibits the matter depofited upon the fkin of the fœtus, and proceeding from the liquor of the amnios as a fort of a tallow mixed with mucilage, or rather as an altered fat matter, almoft adipocirous, analogous to the fat of burying-places, a kind of alteration which the entire fœtus frequently contracts after its death in the uterus, or in the tubes.

9. The water of the amnios of the cow, prefented to the fame chemifts, characters very

I 2 different

different from thofe of the fame liquor in the woman. It has a reddifh colour, an acid and bitter tafte, a fmell of extract, a fpecific gravity equal to 1,098; it is vifcous, ropy, and froths a like folution of gum; it reddens turnfol, precipitates the muriate of barites in abundance; alcohol feparates from it abundant reddifh flakes. When evaporated it becomes covered with an abundant fcum, filled with white, brilliant, and four cryftals; it is reduced into a thick vifcous matter, of a fawn-yellow colour, analogous to honey. This refiduum, treated with boiling alcohol, depofits from this folvent, when it has cooled, an acid cryftallized in brillant needles, feveral centimeters in length, and leaves undiffolved a coloured extractive matter, of a pitchy or gluey confiftence, from which the acid cannot be well feparated except with a large quantity of boiling alcohol, employed at feveral times. Thefe two principal fubftances of which the liquor amnii of the cow appears to be formed, and in which it differs from that of woman, have been examined with much attention, as new and particular matters, by Citizens Vauquelin and Buniva.

10. In order to obtain the acid of this liquor of the cow, it is neceffary to reduce the liquor by evaporation to a fourth of its volume, and to let it cool. The acid cryftallizes, foiled by a portion of extractive matter, which is feparated by means of a fmall quantity of water, without touching the acid. When the water of

the amnios has given by evaporation and cooling, all the concrete acid that it is poſſible to extract from it; if we continue to evaporate it till it has acquired the conſiſtence of a thick ſyrup, there are afterwards formed in it large priſmatic cryſtals, tranſparent, bitter, very ſoluble, which are eaſily recognized to be ſulphate of ſoda: it is ſufficiently abundant; it is alſo extracted from the entire reſiduum of the liquor evaporated to dryneſs, after it has been burned, and by the lixiviation of its coal: it is then white and pure.

The amnic acid, extracted and purified by the proceſs that has been indicated, is white, brilliant, ſlightly ſour, reddens turnſol, is alſo ſoluble in cold water, but a little more ſoluble in boiling water, which depoſits it in cryſtals by cooling. It ſwells upon ignited coals, turns black, exhales ammonia and Pruſſic acid, and leaves a pretty voluminous coal. The alkalies render it very ſoluble, and it is precipitated from them in a white cryſtalline powder by the acids. It does not decompoſe the alkaline carbonates unleſs by the aid of heat; it does not precipitate the earthy ſalts, nor the nitrates of mercury, of lead or of ſilver. It has ſome relations with the mucous or ſacchlatic and the uric acids; but it differs from the firſt in the circumſtance that this, which is inſoluble in alcohol, affords neither ammonia nor Pruſſic acid by the fire; and from the ſecond, becauſe this latter not cryſtallizing like

like it, is insoluble in alcohol, becomes coloure in the air, and is reddened by the nitric acid.

11. As to the coloured extractiform matt which exists in the water of the amnios of tl cow, it is, like the acid, of a particular na ture. The following are the characters whic the authors of this analysis have found in it It is of red-brown colour, of a singular salin taste, of a strong smell analogous to that o evaporated urine, very soluble in water which i colours strongly, and insoluble in alcohol whicl separates it from the water. It affords by dis tillation ammonia, an empyreumatic oil an Prussic acid, like a true animal substance Placed upon ignited coals, it swells much, dif fuses at first a smell of burned bread, after whicl it exhales that of oil, of ammonia, and at las of Prussic acid; it inflames and leaves a volu minous coal, easy to be incinerated, the very white cinder of which is phosphate of mag nesia; it gives to water a certain frothy viscidity; it does not assume the form of jelly nor does it unite with tannin. The nitric acid decomposes it and disengages from it azotic gas and carbonic acid gas, without converting it into acid. It differs in its pro perties from all other animal substances.

These facts relative to the water of the amnios of the cow, whilst they show a great difference between this liquid and that which exists in woman, prove how important it is to multiply

multiply the chemical examination of animal fubftances.

Section II.

Of the Superrenal Liquor.

12. IT is with the intention of omitting nothing that I fpeak of the fuperrenal liquor, rather than to defcribe its real nature, as nothing has yet been difcovered relative to this fubject. Indeed anatomifts and phyfiologifts are hardly well agreed whether there conftantly exifts a matter that deferves to be ftudied under this name. At leaft the learned Haller, after a very circumftantial defcription of the organ in which it is met with, ftill doubts whether there be really in this organ any peculiar humour? however, feveral profeffors of the art have allowed themfelves to form hypothefes, and to propofe theories refpecting the fuperrenal liquor. Gafpar Bartholin confidered it as the fecretory organ of the atrabile, and the refervoir of this humour. Sylvius confidered it as an acrid juice, which being mixed with the blood returning from the kidneys, ferved to dilute it and to render it irritating to the fides of the vena-cava. The illuftrious Morgagni fufpected that the fuperrenal liquor was deftined to fill the refervoir and the thoracic duct in the fœtus, whofe inteftines cannot

cannot furnish this liquor. Some physiologists have even considered it as the seat of some of the passions. All this proves that the uses of this juice are yet altogether unknown; but as they appear to be of importance in the animal economy, both on account of the constancy and the magnitude of the glands which furnish it, and on account of its greater abundance in the fœtus than in the adult, I thought I ought to make particular mention of it.

13. The superrenal glands, or capsules, in which this liquor is prepared, called also *atra-biliary glands*, are situated above the kidneys; and are larger than them in the fœtus. They are oblong triangular bodies, flattened before and above, behind and beneath; and scooped out as it were at the surface, which rests upon the kidney; surrounded with much fat and cellular texture; terminated at their thin extremities by kinds of horns inclined inwards towards one another; receiving many arteries and veins; of a yellow colour; brown outwardly, more pale and reddish in the fœtus, of a granulated texture similar to that of the conglomorate glands, and divided into a great number of globules. Within, the superrenal glands or capsules are of a deeper colour than externally; they are soft, and as it were spongy. They present an irregular cavity, very variable with respect to its size, the sides of which are frequently very near to each other, and as it were glued together by a cellular down; from the bottom, or the lower

lower fide, a cellular prolongation raifes itfelf refembling the comb of a cock, and adhering to the other fides by the fame cellular texture with which thefe fides themfelves are provided.

14. Thefe very remarkable organs, which the anatomifts carefully defcribe in faces, margins, angles, entirely unknown to the ancients, obferved for the firft time by Euftachius, and called by him *renal glands*, afterwards termed fuccentrial glands by Cafferius, who believed them to be fubfervient to the fecretion of the bile, defcribed by Valfalva, Blafius, Morgagni, Harder, Peyer, Fanton, Tifon, Perraut, Vallifnieri, Daubenton, in a great number of the mammalia and birds, diminifh in fize, without ever difappearing altogether, from the moment when the fœtus begins to refpire. There is no doubt that the diftenfion of the lungs, the preffure produced by the lowered diaphragm, the change of the form of the thorax which is enlarged towards the bottom, is the firft caufe, as it marks the firft period of the diminution of thefe glands. The thymus diminifhes in the fame manner and totally difappears in confequence of the dilatation of the lungs. No excretory duct has ever been difcovered in the fuperrenal glands, and it is not accurate to believe, with fome anatomifts, that the veins fituated in the exterior ridge of thefe capfules are perforated laterally by a great number of holes, communicating with their interior cavity, for Haller and Cit. Sabatier have never been able to find thefe holes or this com-

communication by injections; Haller, however, afferts that air pushed through thefe veins in the mammalia, eafily paffes into their internal cavity. Thus the anatomical ftructure has hitherto afforded no light refpecting the ufes of thefe glands.

15. It is in the kind of capfule or interior cavity, and efpecially in the fpongy texture adhering between its fides, that the fuperrenal liquor is found. In general it is only in fmall quantity, conftantly more abundant in the fœtus and infants than in adults, in whom generally only a few drops are found, and more frequently only a foftifh texture, flightly imbued with it, like a fponge, a little moiftened. This humour is reddifh in the fœtus, yellow in the infant, and more or lefs brown in the adult. It appears to vary in its quality as well as in its quantity; it has been indicated by fome as fweet, by others as ftyptic, and by others again as infipid. Some phyfiologifts have compared it to the blood; from which Haller however afferts it to be really different; he affures us that he has feen it coagulated by alcohol. No chemift has yet examined this juice; and it is rather imagination than experience that has attributed different characters to it, according to the different opinions formed of its ufes. As no excretory duct is known, there is reafon to believe that the fuperrenal humour is abforbed by the lymphatic veffels; for the reft, it really remains a ftill unfolved problem, not only to know for what ufes it

is

is deftined, but even todemonftrate its exiftence as a determined and conftant liquid; for no cavity has been found in the fuperrenal capfules of the fquirrel, the bear, the fheep, the dog, the fow, the cat, the rat, the guinea-pig, &c.

Section III.

Of the Meconium.

16. THE meconium is a black, brown, or greenifh-brown matter, of the confiftence of liquid honey, or of a well-boiled fyrup, ropy and vifcid, contained in the inteftines, efpecially the great inteftines, of the fœtus that has not yet refpired, fometimes in confiderable quantity, and exifting in the duodenum, nay even in the ftomach; which the infant generally difcharges a few hours after birth. This liquid, which has ufually been confidered as the firft excrement formed in the inteftines of man, the origin of which is almoft always referred to the bile, is moft frequently without fmell or tafte; fometimes it prefents a flight fetidity. Bordeu, the only phyfiologift who was well aware how interefting a fubject the examination of the meconium would be, and who remarks that feveral anatomifts have fo far neglected it that they have not

not even ſpoken of it in works otherwiſe ſufficiently copious and well written, has paid much more attention to this ſubject than thoſe who had preceded him. He has inſerted in his medicinal analyſis of the blood, an examination of the meconium, made by Bayen and Deleurye. It will be from that article that I ſhall give an account of this liquid.

17. Bordeu ſays, that he found the meconium generally inodorous, and ſometimes of a diſagreeable earthy ſmell; it appeared to him to be not inflammable, more mucous than oily, having no predominant acid or alkaline character, being rather ſaponaceous, ſoluble in water and in alcohol, black in the large inteſtines, and greeniſh in the others. Without explaining himſelf farther upon its real nature and its origin, he however remarks, that the meconium is a ſtercoral matter which ought to be conſidered as the firſt eſſay of the work of the inteſtines. Hence he concludes that the viſcera begin to exerciſe their functions already in the body of the mother. Though the fœtus has taſted nothing, has ſwallowed nothing, though its animal functions have ſcarcely had time to unfold themſelves, the inteſtinal tube, according to this phyſician, has begun to exert the action which it is deſtined to perform during the remainder of life. We ſhall ſee, in the reſearches of Bayen and Deleurye, a confirmation of this notion, and a reſult which renders the opinion founded upon it ſtill more accurate.

18. At

18. At the inftigation of Bordeu, Bayen made an analyfis of the meconium which, though not very detailed, is at leaft fufficient to afford an idea of the general properties and the origin of that matter. This liquid analyfed by Bayen, was of a deep olive colour, of the confiftence of an electuary or a thickened mucilage, without fmell and almoft without tafte; it gave to linen a yellow tinge, which water could not take away, though it acquired a yellow colour. Diluted with fixteen times its weight of water to which it gave an intenfe yellow colour, there was precipitated from it more than half its quantity of a grofs matter, which became brown by deficcation. Heated in an iron fpoon, it fwelled, diffufed a vapour at firft aqueous, afterwards oily, always of a lefs difagreeable fmell than that of the other animal fubftances; it did not inflame though the fpoon was heated to rednefs. Dried in the water-bath, it loft more than $\frac{4}{5}$ of its weight, and prefented a brown opaque mafs, eafy to be pulverized, and exhaling a fweet agreeable odour, analogous to that of infpiffated milk; it was a little bitter. A fmall portion of this dried meconium put to digeft with ten times its weigh of alcohol, gave it a deep yellow colour; this liquor being evaporated left a tenth of its weight of a matter, yellow like faffron, tranfparent, bitter, and in every refpect fimilar to that which is extracted from the bile by the fame re-agent. The refidue of meconium not diffolved by the alcohol was black, though fuf-

ceptible

ceptible of giving a yellow colour to water. The greater portion of the dried meconium, heated in a ſmall glaſs retort, gave half its weight of water, about a twelfth of oil, carbonate of ammonia, and an elaſtic fluid, which Bayen then conſidered to be air. There remained a coal forming a ſixth of the maſs, which ſtill preſented ammonia by roaſting, became incinerated at its ſurface and hard at its centre, after having been kept red-hot for five or ſix minutes, as the coal of every animal matter does. A longer roaſting rendered it friable, though it remained black; it had loſt a little leſs than half its weight, and effervеſced with the nitric acid. Bayen concluded from theſe experiments, that the meconium was not a real excrement, but a milky excrement, already mixed with the bile, as thoſe of adults were.

19. Bordeu then gives ſome obſervations of Deleurye upon the meconium; they tend to aſcertain points oppoſite to thoſe of Bayen, as they indicate a fœtid ſmell, both in this liquid heated alone, and in the ſame juice heated with water. The ſame practitioner remarks that in ſeveral infants that died in their birth, from which he had procured the meconium, he found that the gall-bladder contained a liquid inclining more to red than to the colour of the bile; in fœtuſes that had died before having reſpired, he found no liquid in the ſtomach, but only a gluey reddiſh lining, as was that of the ſmall inteſtines; a white and thick lining in the cœcum: and

and a ſtill thicker one, but brown and reſembling the meconium, in the colon, eſpecially the nearer it approached to the rectum. The internal ſurface of the colon, according to this practitioner, was ſpotted with the brown tinge of the meconium, and very difficult to be cleaned; the rectum was full of viſcid meconium, difficult to be removed, and it obſtinately retained the colour of this excrementious liquid.

20. Theſe parts were ſufficient to induce Bordeu to conſider the meconium as the pureſt part of the bile, accumulated in the liver, turning black in proportion as it loſes water, giving a yellow tinge to the membranes to which it adheres, ſending particular emanations into the ſurrounding parts, mixed with mucous, ſtomachic and pancreatic humours, forming a column of matter upon which the inteſtines mould themſelves, and from which they derive their form. He mentions the caſe of an infant who had died in conſequence of a vomiting of meconium which he had diſcharged by the anus, and in whom the left part of the colon was found contracted like a cord. It is natural to think, according to him, that ſome of the emanations of the meconium paſs into the lacteal veins, and from thence into the blood; he finds in it even the ſource of the colour of the blood, originally developed in the liver, as well as a certain analogy between this colouring matter and the blackiſh humour of

of the ſuccentrial reins. He endeavours to follow this colouring part of the blood in the revolutions of the ſeveral ages till the period of old age, eſpecially in the bilious temperaments; he obſerves it forming the colour of the abdominal blood; he compares and recognizes it in the attrabile or the melancholy of the ancients, denied in vain by the moderns; he announces its cachexy in the *meloena* or *morbus niger* in the jaundice of new born infants, which frequently goes as far as black jaundice; in the mucous texture of the negroes who are born white and grow black only in courſe of time; he believes it admitted even in the black hairs to which it gives colour, in the eye the ſelerotica of which it tinges with its dark pigmentum, or animal ethiops. I muſt not purſue theſe views farther, though they undoubtedly are ingenious, but too far remote from the path of experiment, and too nearly approaching to the hazarded aſſertions of medical theory to deſerve the confidence of chemiſts. New reſearches muſt enable us to determine how much reality there may be in theſe notions: the object is well worthy of all the zeal and induſtry of thoſe phyſiologiſts who knowing the utility of chemiſtry, may find themſelves in circumſtances favourable to the ſucceſs of thoſe uſeful inveſtigations.

ARTICLE

Article XXV.

Of the Urine.

1. THE urine of man is one of the animal matters that have been the moſt examined by chemiſts, and of which the examination has at the ſame time furniſhed the moſt ſingular diſcoveries to chemiſtry, and the moſt uſeful applications to phyſiology, as well as the art of healing. This liquid, which commonly inſpires men only with contempt and diſguſt, which is generally ranked amongſt vile and repulſive matters, has become, in the hands of the chemiſts, a ſource of important diſcoveries, and is an object in the hiſtory of which we find the moſt ſingular diſparity between the ideas which are generally formed of it in the world, and the valuable notion which the ſtudy of it affords to the phyſiologiſt, the phyſician, and the philoſopher. The numerous and important facts which its hiſtory comprehends, and the neceſſity of preſenting them in a methodical manner, induce me to divide this article into ten paragraphs. The object of the firſt will be the natural hiſtory or the formation of the urine; of the ſecond, the knowledge of the phyſical properties which characterize this liquid; of the

third,

third, the expofition of the principal difcoverie to which it has given rife; of the fourth, th examination of its chemical properties; of th fifth, that of the different materials which ar extracted from it by analyfis; and whicl conftitute it by their fimultaneous folution i water; in the fixth, I fhall particularly con fider an urinary fubftance which belongs onl to this liquid, and gives it its true characterifti properties; in the feventh, I fhall defcrib the varieties which the urine prefents in different circumftances of human life; in the eighth, that which it prefents in the different animals; finally, the ninth paragraph fhall be employed in fhewing the influence which the difcovery of the materials of the urine muft have upon the progrefs of human phyfiology; and the tenth, in announcing the very numerous ufes for which urine is employed, both in medicine and in the arts.

Section I.

Natural Hiſtory or Formation of the Urine.

2. THE kidneys, the venal or emulgent arteries and veins whichare diſtributed in them, the ureters which proceed from them, the bladder into which the former open, and which is terminated by the canal of the urethra: theſe comprehend the whole apparatus which nature employs for ſeparating the urine and evacuating it out of the human body. The kidneys, ſurrounded with a great abundance of fat, and ſituated on the outſide of the peritoneum, in the poſterior part of the abdominal cavity, compoſed of a very denſe fleſhy texture, granulated when torn, and itſelf formed of a great quantity of convoluted veſſels, receive an abundant maſs of blood, proceeding immediately from the aorta, and ſtill poſſeſſing a conſiderable velocity, though the renal or emulgent arteries go out from it at a right angle, a poſition which retards its motion. It is commonly believed that the urine comes immediately from the blood, and that the water which conſtitutes its greater part was ready formed in the latter liquid. It is however poſſible that this water might be formed in the

secretory organ itself, at the expense of the decomposition of the blood; but the decision of this important question requires observations and experiments made purposely and in an order relative to these researches. Anatomists describe three different substances in the texture of the kidneys; the external or the cortical, which is the thinnest, the most dense and most coloured, the middle or the tubulous and the interior or the papillary. The first separates the urine; the two others conduct it into between eight and twelve cups or funnels which receive the extremities of the papillae, and which open into a membranous cavity called the *pelvis.*

3. This membranous bag or basin, placed in the hollow of each kidney, under the vessels, and supported upon the interior and posterior layer of these viscera, gradually receives the urine running from the papillae into the calices, and conveyed by the latter. In proportion as it arrives in the pelvis formed by a dense membrane, it descends by a duct extending obliquely on each side from the kidneys to the bladder, and traversing the posterior part of the abdomen, the bottom of the pelvis, to open into the lower and posterior region of the urinary bladder. This double canal, which is called *urether*, is of the thickness of a moderate sized quill, flattened as it were, and formed of a single membrane, which is very hard, little susceptible of dilatation in the sound state, neither

ther mufcular nor irritable, performing the ıction of a fimple tube, or of a long funnel-k, in which the urine is never detained. :hofe rare cafes, in which there is only one ney, fituated upon the middle of the fpinal ımns, two ureters are generally found; ch proves that thefe are two kidneys clofe ether, and with their fubftance intermingled; ıetimes there exift three kidneys, which are ı provided with three ureters.

. The bladder, fituated behind the pubis, in fmall pelvis, projecting after infancy a le above thefe bones, nearly of the form of a ıcated cone, with its bafe downwards, is ıpofed of two principal membranes, the fcular, which is pretty ftrong and irregular the direction of its fibres, which are con-ıfed and accumulated; efpecially towards the tom; the other, cellular or villous, folded 'ards, fometimes even forming a kind of jecting columns, and particular cavities or ıll bags. The bladder is retained in its place a very abundant cellular texture condenfed ı ligaments towards the inferior, fuperior ! pofterior parts; it prefents towards the rum a depreffed part, which is called its *fun-*; in its interior it exhibits, between the two ique orifices of the ureters and the orgin of urethra, a projecting triangular fold, and a ıercle towards the urethral orifice; it is more vated in the fœtus, and it has towards the per part a duct called *urachus*; it is widened into

into the form of a barrel in pregnant women' and is then detached from the peritonæum which in the ordinary ſtate covers its fundus; it receives the urine, which is continually poured into it, in ſmall uninterrupted ſtreams, intermittent however with reſpect to the quantity and velocity. The capacity of the bladder amounts to ſeveral litres, and varies greatly. The urethra, or the canal that terminates the bladder, which proceeds outwards, and forms a part of the penis in men, opens at the upper part of the vagina with women, below the clitoris and between the nymphæ, affords a paſſage to the urine, and evacuates it out of the body.

5. When the urine has remained for ſome time in the bladder, which is distended by it, and eſpecially when it is very abundant, it irritates the fibres of this organ, produces an urgent deſire, and is diſcharged by the preſſure which the will produces upon the ſides of the bladder; it is evacuated in a more or leſs rapid ſtream, according to the acrimony and the quantity of the urine, according to the senſibility of the bladder, and the energy of its fibres: a too great diſtenſion frequently cauſes it to loſe its contractile force, on which account it is always dangerous to reſiſt the inclination to void the urine, and not to ſatisfy it as ſoon as it is felt. When the urine paſſes through the canal of the urethra, and is diſcharged in a continued ſtream, it frequently excites a more or leſs irritating and hot ſenſation, ſometimes

even acrid and burning, when it is too much charged with its principles, and commonly when we have drank too much of ſpirituous liquors, or uſed too violent exercise. The ſlighteſt morbid irritation in the canal of the urethra renders it alſo exceſſively ſenſible, and changes into pain the evacuation of the urine, which in the natural ſtate of perfect health is attended with no particular ſenſation, and eſcapes almoſt without its paſſage through this canal being perceived.

6. Two and even three ſpecies of urine are diſtinguiſhed, according to the times at which it is voided: the firſt is called the urine of the drink, or crude urine; the ſecond the urine of digeſtion, or of the chyle; the third, the urine of the blood.

The firſt is called the urine of the drink, becauſe it is voided immediately after a meal. This is not even real urine; it has generally neither the ſame ſmell, colour, nor weight; it contains very little matter in ſolution, and it is not this liquor that we ought to examine, in order to aſcertain the nature of the urine; it is ſometimes diſcharged in conſiderable quantity.

Urine of digeſtion, or of the chyle, is that which is diſcharged two or three hours after a meal, and which is diſtinguiſhed by a more intenſe colour than the firſt, as well as by the ſmell, and even the taſte of the aliments that have been taken: this is not yet perfect urine, or

or that which ought to be chofen for experiments intended to afcertain the real principles of this excrementitious liquid.

7. Seven or eight hours after a meal, and efpecially in the morning when the perfon has flept for feveral hours after fupper, there is difcharged a coloured, acrid, fapid, and highly odorous urine, not prefenting the characters of the aliments that have been taken, but of a particular odour which is peculiar to it; in a word, a well constituted urine, enjoying all the properties that appertain to it. The circumstances of digeftion, the nature of the aliments, exift no fenfible influence, or at leaft a much lefs influence, upon this: and for this reafon it has been called the urine of the blood. When we choofe this genuine urine, voided by an adult, healthy and vigorous fubject, and examine it immediately after it has been difcharged, and efpecially without waiting till it has undergone the fpontaneous alteration of which it is fufceptible, as I shall show hereafter, we find in it all the characters which diftinguifh this kind of excrementitious liquid: it is alfo this urine of coction, this urine perfected by nature, which remains for the leaft space of time in the bladder, which produces the most urgent inclination to void it, and which cannot be retained without much greater danger than the two preceding kinds.

8. The large quantity of urine which frequently is voided a very few moments after drinking;

drinking; and the rapidity with which an odorous ſubſtance brought in contact only with the ſkin or lungs is tranſmitted into this liquid, have rendered it doubtful whether it always goes through the medium of the circulation, and have led to the belief that there exiſts another paſſage for the tranſmiſſion of liquids. It has been imagined, that water impregnated with different ſubſtances might filtrate into the bladder without paſſing through the kidneys; and though no duct, except the ureters, has been found that opens into the reſervoirs, ſeveral phyſiologiſts have believed that ſuch exiſt, or have, and that the lymphatic veſſels perform theſe functions. However this may be, it is certain that there exiſts a reciprocity, a correſpondence of action, a very remarkable ſympathy of effect between the ſkin and the bladder, or the kidneys, or to ſpeak more accurately, between the tranſpiration and the urine; that when the firſt is very abundant, the ſecond is diminiſhed; that when the tranſpiration is ſtopped, the flow of the urine is augmented, and that there ſeems to exiſt a kind of regurgitation between theſe two humours. Circumſtances alſo occur, in which the tranſpiration preſents the properties of the urine, though in a much inferior degree, yet in a ſufficiently perceptible manner to prove a ſtriking analogy between theſe two excretions. The most able modern phyſiologiſts ſimply explain this reciprocity of effects between the diſcharge by

by transpiration and that by the urine, by the general repletion of the vafcular fyftem, which communicates itfelf eafily and pretty rapidly from one contiguous part to another.

9. We may alfo perceive a fympathy between the ftomach and the organs deftined for the fecretion of the urine: a multitude of alimentary fubftances and drinks tranfmit from the interior of the ftomach, into which they have been received, more or lefs fenfible properties to the urine, within a few minutes after they have been introduced into it. This phenomenon is very perceptible, efpecially with perfons of delicate and fenfible habits of body with whom digeftion is frequently laborious and feeble: we may diftinguifh the nature and characters of the aliments which they have just taken by the fmell of their urine. This not only holds good with refpect to fubftances which are naturally very odorous, fuch as garlic, onions, afparagus, the aromatics, the balfams and perfumes, but alfo with refpect to thofe that have only a very flight, and fometimes fcarcely perceptible fmell. I have obferved, as Macquer had indicated, that the urine of hyfterical women and hypochondriacal men, voided immediately after meals, had the fmell of the bread, the foup, and the meat which they had eaten. It does not appear to be neceffary, in order to explain this phenomenon, to admit veffels communicating from the ftomach to the kidneys, or even the bladder, the exiftence of

which is rejected by the most able and accurate anatomists. The lymphatic fyftem is adequate to perform this function, which ought not to be attributed to a particular glandular apparatus.

10. The cafe is the fame with the relation to the re-action which exift between the evacuation of the urine and the functions of the inteftines. It is frequently obferved, that abundant liquids, which for fome time diftend the inteftinal tube, pafs off by urine, of which they produce a confiderable difcharge, and that, on the other hand, the urinary matter when detained in its fecretories, and unable to pafs off by the ureters, procures itfelf a vent through the inteftines, when it is evacuated in the form of a ferous diarrhœa. Glyfters injected by the anus very frequently pafs into the bladder: the abforbent veffels, which exift in great quantity in all thefe organs, eftablifh a prompt and eafy communication between them. We alfo obferve the fame circumftance with refpect to the abdominal cavity in which the hydropic water is accumulated: frequently this liquid is evacuated by the urethra, and there is no reafon to believe that it has paffed through the kidneys. As it is fometimes conducted by the abforbent veffels into the inteftinal canal, there is no reafon why it fhould not be conducted in the fame manner into the bladder, which alfo receives many of thefe veffels at its furface.

Section II.

Physical Properties of the Urine.

11. WE have seen that there may be discharged, and that actually there is frequently discharged by the urethra a liquid which has not the true characters of urine, though this name is constantly given to every liquid that passes off in this way; that it is only several hours, seven or eight, after meals that the true urine is evacuated; that the other liquids either do not enjoy its properties, or present them only in a very slight degree. Accordingly, it is only that urine, the discharge of which is subsequent to the complete digestion of the aliments, and the mixture of the chyle with the blood, which must be examined in order to ascertain its characters. We must choose such as has been voided by a healthy adult after waking in the morning: in this case it has all the properties that belong to it. The urines of drink or of meals, as well as those of hysteric diseases or attacks, and those which accompany grief, fear, and the depressing passions in general, form exceptions and modifications of this liquid, more or less remote from the natural state, and presenting results more or less different.

12. The

12. The quantity of the urine, as muſt be conceived from what I have already ſaid reſpecting its formation, varies in almoſt infinite degrees; phyſiologiſts therefore have been much embarraſſed to determine it. Haller, who devotes one of the paragraphs of his Phyſiology to this calculation, begins with affirming that he cannot define it in the healthy ſubject; it ſingularly follows the quantity of the tranſpiration, with which it is almoſt exactly in an inverſe ratio; it exceeds the tranſpiration in the proportion of 3 to 1 in the cold and wet months; in the hot and dry ſeaſon it is leſs abundant than it. In the intermediate ſtate of the atmoſphere its quantity is equal to that of the humour evacuated by the ſkin: it is generally more abundant with old perſons, whoſe ſkin is more denſe, and loſes leſs; in youth, the tranſpiration is to the urine as 1340 to 1000; in old age, on the contrary, it is as 967 to 1000. In bed, the urine is to the tranſpiration as 4 to 3. Such is the reſult of the experiments and calculations of Robinſon, as admitted with confidence by Haller.

The proportion of the drink has much influence upon that of the urine, as we obſerve in ſick perſons and thoſe who take the mineral waters; Dodart eſtimated its quantity to be equal to that of the liquids received; Cheyne eſtimated it only at three quarters; from a compariſon of the reſearches of Sanctorius, Keil, Robinſon, Gorter, Rye, Home, Dodart, Linings,

Linings and Cheyne, Haller gives for the various quantities of urine voided in twenty-four hours, the fums of 28, 31, 36, 38, 40, 44, 50, and even 64 ounces, the mean term of which quantities is 49. Nothing accurate can be eftablished upon thefe refults, which prove that the proportion of the urine is extremely variable.

13. Though we may to a certain point admit the fame variation in all the phyfical properties of this liquid, we find however more conftancy and ftability in moft of them. One of the moft marked and moft certain characters of the urine is its colour; no animal liquid prefents a fimilar one, and it is exclufively given to it by nature. This colour, which varies in its intenfity from a lemon yellow to a deep orange, is owing to a particular matter, the relative proportion of which to the water, produces all the poffible tinges that are known. Bellini, who occupied himfelf much with urine, in a medicinal point of view, underftood this fact refpecting its colouration; he afferted that the urines differ in their moft diffimilar colours, from the paleft to the moft intenfe, only from the relative quantity of water: fo that, according to the obfervation of Boerhaave, which is only a confequence or inference from the opinion of Bellini, we can produce from the moft intenfely coloured urine, all the intermediate tinges to the very paleft, and thus imitate the procefs of nature; nothing

nothing more being required than to add different quantities of water. It however muſt be remarked, that the lemon or ſlightly orange colour, joined with perfect tranſparency and limpidity, which announce a liquidity very homogenous in all its parts, is the true characteriſtic and natural tinge of the urine of a healthy perſon. I do not here ſpeak of the varied colours which the urine affects under certain pathological circumſtances, of the red and inflammatory urine, of the ſaffron coloured urine, of the black urine of melancholic affections, of the green urine of patients labouring under jaundice, of the blue urine obſerved in ſome caſes of ſtranguary. Theſe different colours indicate deviations from the healthy ſtate.

14. The ſmell of the urine is alſo a property which belongs excluſively to it, and has not yet ſufficiently engaged the attention of phyſiologiſts. Immediately after it has been diſcharged, the urine, while ſtill hot, has a ſmell which is truly aromatic, has nothing fetid, or ammoniacal or acid, and reſembles nothing elſe, but is ſo well characterized that no other natural ſubſtance can be confounded with it: that which approaches the neareſt to it is the odour of the violet; but the ſmell of the urine is ſtronger, more pungent and more exalted; it is never alkaline or ammoniacal unleſs when the urine has ſuffered a commencement of alteration: accordingly, when ammonia is characterized by the expreſſion of an urinous ſmell,

ſmell, this ought to be underſtood only of urine already putrefied. It is very remarkable that the ſmell which moſt reſembles that of freſh, healthy and warm urine, is the aroma of the tranſpiration, which is diſcharged in the fluid ſtate by healthy perſons; we find it alſo in the perſpiration of the horſe when undergoing violent exerciſe. We ſhall hereafter ſee that this depends upon the preſence of a matter peculiar to the urine, and which exiſts ſometimes, perhaps even always, but only in ſmall quantity, in the humour of the tranſpiration and moiſture of the ſkin.

15. The urine, when diſcharged from the bladder, has a temperature equal to that of the internal part of the body, namely from 29 to 32 degrees, according to the thermometrical ſcale that marks 80 or 85 for ebullition: this gives $36\frac{1}{4}$ for the centigrade thermometer. It exhales into the air a portion of odorous water as long as it preſerves its heat: this water is in the ſtate of a viſible fume when the air of the atmoſphere is at 5 degrees ×0 and moiſt; it is perceptible only by its odour when the atmoſphere exceeds 10 degrees ×0. It is aſſerted that, in ſome diſeaſes, the urine has a more elevated temperature, which is difficult to be believed according to the known laws of the animal economy; it is even almoſt impoſſible that its temperature ſhould be lower. In proportion as it loſes the elevation of its temperature, it likewiſe loſes its aromatic ſmell. Sometimes

times it becomes turbid by mere cooling, either in confequence of its own highly charged ftate, as in the crifes of difeafes, or in winter when it is cooled in a very confiderable degree, or in the fummer after a violent ftorm. We fhall hereafter explain the caufe of this precipitation.

16. The fluidity of the urine, though at firft fight refembling that of water, prefents however, when confidered with attention, a fenfible difference. We foon perceive an adhefion between its particles fomewhat fuperior to that which exifts between thofe of the aqueous fluid; though it is much lefs ftrong than is obferved in the ferum of the blood, the faliva, and efpecially the bile, which is always ropy. However flight it may be in the natural and healthy ftate, we fee at leaft that it is very much difpofed to become in a very fhort time more confiderable, in confequence of the flighteft change that may take place in this humour, either with refpect to its own compofition, or with relation to the bladder in which it is accumulated and detained. With infants, it is mucous, and flightly adhefive. In all the difeafes in which the patient waftes away, and efpecially in phthifical cafes, it becomes mucilaginous and gluey. In the calculous affections, and whenever the bladder is irritated, the urine acquires fo vifcid a character that we fee it filled with femi-concrete flakes and

 filaments.

filaments. The different degrees of confiſtence and viſcidity which it frequently acquires from ſlight cauſes, depend upon a gelatinous mucilage, the proportion of which is ſuſceptible of a great number of variations, but which is always contained in it, as I ſhall ſhow in the ſubſequent paragraphs.

17. The ſpecific gravity of the urine is alſo a variable character. Some phyſiologiſts have erroneouſly aſſerted that it is lighter than water: it is conſtantly heavier, but its increaſe of denſity has ſomething ſingular in it, when we know that it contains a conſiderable quantity of ſubſtances in ſolution. We are led to believe from this property alone, that the materials which conſtitute it, are themſelves rather light bodies: we ſhall ſee hereafter how much foundation there is for this notion. Silberling, in his Treatiſe on the ſpecific gravity of the animal humours, eſtimates that of the urine with reſpect to water, as 271 to 261; Hamberger, as 399½ to 388; Davies, as 1080 to 1000. Bryan Robinſon aſſerts that, in middle age, its weight is to that of water, as 10300 to 10000, and with old perſons, as 10218 to 10000; Muſchenbrœck gives its proportion as 1030, water being 1016. Briſſon, in his Table of the ſpecific gravities of bodies, finds it 10106. It has been obſerved, that when the denſity or ſpecific weight of this excremental liquid increaſed, and continued for ſome time in its augmenta-

tion, it was a dangerous ſymptom for the health of the individuals in whom it preſented itſelf.

18. The taſte of the urine is pungent, ſaline, a little acrid, and ſlightly bitter. As this property varies in a multitude of caſes according to the ſtate of diſeaſes, anatomiſts and phyſicians have obſerved in it various acrimonies, which they have deſcribed as pathological ſigns or characters. The ſaline or marine acrimony, which is the moſt frequent of all, and is conſtantly found in this liquid, has been attributed to the preſence of muriate of ſoda; it is from this kind of acrimony that the ſenſation of thirſt ſeems to proceed, which is excited by urine uſed as drink, either in caſes of urgent neceſſity, or for medicinal purpoſes. Holwell, when confined in the black-hole at Calcutta, found the thirſt, with which he was cruelly tormented, greatly relieved by ſwallowing his perſpiration; but it was impoſſible for him to drink his urine. The chief reaſon why this ſaline acrimony has been admitted is that the firſt chemiſts who examined the ſalts of the urine, Van Helmont, Henckel, Tacheneus, Boyle, Bohnius, Neumann and Spielman, conſtantly found the muriate of ſoda in this liquid, and conſidered it as the moſt abundant ſaline principle of the urine.

19. The alkaline acrimony of the urine, that is to ſay the circumſtance in which the urine is alkaline, never takes place in the healthy ſtate.

It is met with only in cafes where the urine has already been altered in its refervoirs, as it happens when out of the body. But as it is actually very much difpofed to contract this character, it happens frequently that it exhibits it in difeafes, efpecially in thofe in which it is detained, for a more or lefs confiderable time in the bladder. After fome hours, this alkalefcence developes itfelf in the urine ; it then turns the blue vegetable colours green, and even proceeds fo far as to produce effervefcence with the acids. It is on this account that it becomes ufeful in fulling, that it eafily takes off the greafy impreguation from the fleece of the fheep, and that it afterwards lathers with water. However we muft not confound this acquired acrimony, to which the urine is indeed very much difpofed, with its natural ftate which prefents nothing of the kind.

20. As to the acid acrimony, it is that which may be admitted with the greateft utility and truth, becaufe healthy urine is naturally four. It is true, that this fournefs is fo flight, that it is difficult to perceive it, even when we tafte urine with much attention. Neverthelefs the four fmell of urine has been dfecribed. Vieuffens and Mariotte have afferted that urine reddened feveral blue vegetable colours ; that this acidity was loft in the courfe of time, and that it paffed into the ammoniacal ftate. We fhall hereafter fee the caufe of this change, which actually takes place. Several phyfiologifts have maintained that the urine is neither acid nor alkaline, and this is the

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opinion which Haller supported : he attributed the acidity of the urine, which in fact is so slight as to redden only the most delicate blue vegetable colours, to the drink that may have been used and especially to rhenish wine ; but the urine is acid with individuals who drink no wine, so that it is impossible to conclude that its acidity proceeds from this liquor, and we may assert that the natural acrimony of the urine is acid.

SECTION III.

Historical Sketch of the Chemical Discoveries made upon Urine.

21. I HAVE already observed that the urine has been the subject of numerous and important researches, and has afforded occasion to chemists for making many discoveries. I shall here point out the principal epochas of those discoveries and their authors. But I shall omit the mention of the writers who have occupied themselves with it only under a medicinal point of view, because these kind of researches, which are useful when severe and accurate observation presides over them, have been tarnished in their lustre by the hypotheses with which they have been loaded ; they have been disgraced by the absurd pretensions of uroscopes and uromancy ;

of the chemical knowledge of his times to phyſiology and the art of healing.

26. Boerhaave has given, in his Elements of Chemiſtry, nine proceſſes upon the properties and the analyſis of urine: and he, amongſt all the medical chemiſts from the commencement of the eighteenth century, has added the moſt to the firſt eſſays of Boyle upon this excremental liquid; for Stahl is remarkable in this part of the hiſtory of the ſcience only by the ſingular obſtinacy with which he maintained that it was the marine ſalt contained in urine which yielded the phoſphorus, and that the muriatic acid was to this combuſtible body what the ſulphuric was to ſulphur; an error with which ſevéral writers have juſtly reproached him, and which forms a blot in his works, otherwiſe ſo commendable for the clearneſs and method which pervade them. In his nine proceſſes, Boerhaave endeavoured to prove that the urine was neither acid nor alkaline, that it afforded no alcohol, but a fetid principle analogous to that of the ſweat, and a putrid oil; that it contained nothing chylous, nutritious or coagulable by fire, but only acrid, putrid attenuated matters, dangerous to health, that after the horribly fetid oil which is extracted from it by diſtillation, there remained a coal from which muriate of ſoda but no fixed ſalt might be extracted; that fixed alkali and lime diſengaged from it an acrid matter, a kind of vapour dangerous by its action upon the body; that the urine

that Van Helmont had a better infight into the nature of the human urine than all his predeceffors. But thefe rays of light, inveloped in a mafs of obfcurities and extravagancies, efcaped his age; befides which he has not defcribed one experiment, nor even indicated one pofitive fact, in fupport of his truly unheard of conceptions, as he himfelf denominated them.

23. It is to Boyle only, towards the end of the feventeenth century, that the firft chemical experiments made upon the human urine are to be traced. The difcovery of phofphorus, made it 1796, by Brandt, of Hamburgh, who operated upon the urine with alchemical views; the labours of Kunckel, who fucceeded in preparing it with the refiduum of the evaporation of this animal liquid, gave, as it appears, to Boyle, the inclination to make a fubfequent examination of this liquid, and he depofited in 1680, at the Royal Society of London, a fmall piece of phofphorus which he had extracted. He communicated his procefs to Hawkwitz, a druggift of London, who occupied himfelf during feveral years with this originally urinary preparation, and fold phofphorus for more than twenty years to all the philofophers of Europe. We fee that it is to this combuftible body, which was long called phofphorus of urine, that we owe the firft feries of chemical experiments that has been undertaken upon this liquid. For I can fcarcely reckon amongft thefe experiments the employment of urine for the different proceffes of fulling woollen

this might be extracted from the refidue of the diftillation of the phofphorus of urine by lixiviating it; that the muriate of foda never afforded phofphorus, notwithftanding the affertion of Stahl. He difcovered that by diftilling the calcined extract of urine with muriate of lead, phofphorus was obtained from it; and as the fucceffive labours of Schloffer, of Haupt and of Klaproth upon the fufible falts of the urine, have exhibited the two phofphates, we fee that Margraff, without knowing that of foda, had found the means of decompofing it by the muriate of lead. We here again perceive the influence which the enquiries relative to the extraction of phofphorus have conftantly had upon the analyfis of the urine, and how much they have contributed to the determination of its faline materials.

28. It is in the fame order of experiments upon the urinary falts and upon the nature of the phofphates that we muft rank the fine differtation of Pott upon the *fufible falt* of the urine, or the *microcofmic falt*, publifhed in 1757; the differtations of Haupt, of Schloffer, of Schockwitz, of Prouft, of Bergman upon the different faline fubftances which it contains; the experiments of Chaulnes upon the purification of this falt; finally, the much more complete and much more important labours of Rouelle the younger upon the analyfis of the urine. This able analyft, of whom I have fo often had occafion to fpeak, gave in November, 1773, in the

the *Journal de Medicine*, ſome valuable obſervations upon the comparative analyſis of the urine of man, of the cow and of the horſe. He firſt announced a ſaponaceous matter, cryſtallizable, deliqueſcent, ſoluble in alcohol, affording more than half its weight of volatile alkali by diſtillation. He indicated the great chemical difference exiſting between the urine of the drink and that of digeſtion, and that which diſtinguiſhes putrid from freſh urine: he diſcovered that the urines of the cow and the horſe, being without phoſphoric ſalts, contain a ſaponaceous matter like that of man, with chalk which ſeparates from it by cooling, and benzoic acid. He likewiſe announced the ſeveral different ſalts which exiſt in each of theſe urines, and the art of ſeparating them from one another; he found the ſulphate of ſoda in the human urine, and the ſulphate of lime in that of the horſe.

In July, 1776, he inſerted in the ſame journal ſome very well made experiments upon the phoſphates of ammonia and of ſoda, to the firſt of which he gave the name of *fuſible ſalt*, with baſe of volatile alkali, and to the ſecond that of fuſible ſalt with baſe of ſoda; and he deſcribed the means of ſeparating and diſtinguiſhing them, as well as ſeveral remarkable phenomena of their purification and their ſpecific properties.

Laſtly, in April 1777, he inſerted in the journal de medicine ſome obſervations upon the urine

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SECTION IV.

Account of the Chemical Properties of the Human Urine, and of its Analyfis.

31. IN the confiderable feries of experiments that have been made upon the human urine, moft of the means which chemiftry prefents for determining its nature and afcertaining its principles, have been exhaufted. The action of different temperatures, evaporation carried to more or lefs extent, refrigeration fucceeding evaporation, congelation, diftillation on the water-bath, and by the retort, have furnifhed many ufeful proceffes. Expofure to the air, fpontaneous alteration, fermentation, and flow evaporation have been employed with equal fuccefs. The mixture of a great number of re-agents; the action of water, of the acids, of the earthy and alkaline bafes, of the falts, of the metals and metallic folutions, have alfo thrown light upon the chemical properties of urine and its component parts. Laftly, it has been placed in contact with different vegetable fubftances, efpecially the colouring matters, alcohol, and tannin; and refearches of this kind have even been carried fo far as to examine it by different animal fubftances. As none of the

effects which it presents by these different modes of treatment is unimportant with respect to the knowledge of its properties, I shall here give the result of all the phenomena to the discovery of which they have led.

32. When fresh urine is heated in open vessels by a mild heat and without making it boil, water is disengaged with a urinous but not fetid odour; the colour of the liquid becomes more intense and changes to a bright red; it soon becomes turbid and deposits a whitish or slightly coloured powder, with some coagulated flakes similar to the albumen. The smell, which at first was aromatic, soon changes to an ammoniacal odour, though the liquid be not heated to ebullition; this ammoniacal smell has at the same time something acrid and pungent. The urine, which in its natural state always reddens turnsole, no longer reddens it at this period, but on the contrary it turns paper blue that has been reddened by an acid, a proof that it then contains an excess of ammonia, which is formed in it by the action of the fire. In the progress of this operation, by which we may reduce it to different degrees of consistence, and even to dryness, the urine passes from red to a brown colour; and if, when it is of the consistence of a thin syrup, we place it in a cool and quiet situation; a large quantity of brown or impure crystals are formed, which have been called, *fusible or microcosmic salt, native salt of urine.* The liquor being decanted off, it is

better from the phofphate. He followed the fame procefs in order to obtain the laft portions of falt from the mother-waters: three or four years of fpontaneous evaporation were fcarcely fufficient to exhauft them of this falt. He alfo evaporated the urine to a confiftence thicker than that of a fyrup; he then placed it upon a cloth, wafhed the marine falt that was left upon the filtre, added this lixivium to the matter which he alfo diluted with water in order to prevent its cryftallizing and to render it more liquid than a fyrup; he added carbonate of ammonia to it, then evaporated it again by fire, and by afterwards expofing it to the air, he obtained abundance of fufible falt. He alfo recommended the precaution not to fubject this concentrated liquor to fpontaneous evaporation except in fine weather, but to keep it in the winter in well-clofed veffels, in order to prevent its abforbing humidity.

35. The purification of the fufible or native falt, formed of the phofphates of ammonia and of foda and of muriate of foda, was alfo formerly one of the principal operations that were performed upon the urine. Margraff occupied himfelf much with it in 1743, Pott in 1757, Schloffer in 1760, Haupt in 1740, Chaulnes in 1773, and Rouelle the younger in 1776. I fhall prefent to the reader the obfervations of the laft-mentioned chemift, which contain what is of the moft importance and the greateft utility to be known refpecting this fubject. This able chemift

chemist, considering, like all the authors who had preceded him, the phosphate of ammonia as the true fusible salt, because he well knew that this alone affords phosphorus in its distillation with charcoal, begins with observing, that this salt, when extracted from the urine by the foregoing processes, is very impure and mixed with a saponaceous brown matter which he calls *soapy*, with muriate of soda, and with another salt affording voluminous and efflorescent crystals; this is the phosphate of soda which before him had been taken for sulphate of soda. By dissolving this impure fusible salt, composed, as we see, of four different substances, in five or six parts of slightly heated water, and after filtration through paper, by evaporating the solution, there is first disengaged ammonia and entire fusible salt, which attaches itself in white points and in a crust to the empty part of the basin, and even upon the furnace which sustains it. Rouelle attributes to the water and to the ammonia, this elevation of phosphate of ammonia, which, he asserts, is deprived of its volatile alkali, because, according to him, it produces an effervescence, with the liquor which contains an excess of it, and with a solution of carbonate of ammonia when applied to it with a straw. The liquor must not be evaporated to the formation of a pellicle; it afterwards affords by cooling, and especially by spontaneous evaporation in the air, the phosphate of ammonia which crystallizes first; above this larger

larger cryſtals of phoſphate of ſoda place themſelves, which are diſtinguiſhable by their volume, their form of compreſſed tetrahedrons, their efflorefcence, and the opaque glaſs which they afford in the fire. Rouelle recommends to add ammonia to the evaporated liquor, or whilſt it is evaporating, or to ſaturate it while cold with this alkali and even to add an exceſs of it, in order that there may be no reaſon to fear the viſcid conſiſtence which the inſulated phoſphoric acid gives, and oppoſes the cryſtallization of the ſalt.

36. All that has been ſaid of the evaporation of urine by the fire, belongs almoſt excluſively to the means and proceſſes proper for extracting its ſalts. I ſhall now conſider the operation under a new point of view, as adapted to lead to other reſults reſpecting the analyſis of the urine. Citizen Vauquelin and myſelf, in our enquiries reſpecting this liquor have found that when it was evaporated by a mild heat till it had acquired the conſiſtence of a very thick ſyrup, the whole concreted by cooling into a cryſtalline lamellated or granulated maſs, of a dark brown colour, and of a very pungent ſmell and taſte: this maſs did not reſemble honey or caramel, as Rouelle has aſſerted. Excepting the proportion of carbonate of ammonia diſengaged with the water during the progreſs of the evaporation; (for we convinced ourſelves by performing this evaporation on the water-bath on cloſe veſſels, that ſuch

ſuch a product was volatilized) this cryſtalline maſs exhibit to us all the materials of the urine in a concentrated form; we therefore ſought the means of analyſing this extract of urine and ſeparating its different conſtituent materials. We employed alcohol for this kind of analyſis; it diſſolved almoſt all the urinary matter with the aid of a mild heat; there remained undiſſolved only a ſmall quantity of a grey, cryſtalline, granulated dirty powder, which cold water almoſt totally diſſolved: the portion not diſſolved by the water was phoſphate of lime and uric acid; a lixivium of pot-aſh ſeparated the latter from the earthy ſalt. The water held in ſolution muriates of ſoda and of pot-aſh, phoſphates of ammonia and of ſoda. The whole of theſe ſaline matters that had eſcaped the action of the alcohol amounted only to ſome thouſandths of the original weight of the urine; while the ſubſtance diſſolved in the alcohol amounted to ſeveral hundredths of the liquor and was much ſuperior in quantity to all the ſaline matters taken together. This ſubſtance, already announced in the mother-water of the urine that had furniſhed the fuſible ſalt, is therefore the moſt abundant and the moſt important material; it is this which gives it its principal characters, and will be particularly examined in one of the paragraphs of this article.

Here we have, therefore, a method of analyſis which may ſerve to ſeparate the different materials of the urine and even to determine their

4 proportions,

proportions. It resembles that which is practised upon the mineral waters ; it requires only a well-conducted evaporation, a speedy refrigeration, and a successive treatment of the whole crystalline mass which it affords by alcohol, of the undissolved portion by water and by the ley of caustic alkali, as well as the graduated evaporation of the alcoholic and of the aqueous solutions. Indeed, the first of these solutions does not contain the colouring, odorous, and urinary matter simply, but always combined with muriate of ammonia, muriate of soda and benzoic acid in small quantity ; but we again find these last-mentioned bodies, and can even determine their proportions pretty accurately, by other means of analysis which I shall point out.

I have observed that by evaporating the urine in close vessels and by the heat of the water-bath, we might likewise obtain it of a thick and crystallizable consistence. I must add, that the first water which passes has but little smell ; that in proportion as the urine becomes coloured, thickened, condensed, and loses its water, it undergoes an alteration in its constituent matter which converts part of it into carbonate of ammonia, it is on this account that the last water obtained is charged with carbonate of ammonia and produces a lively effervescence with all the acids. The quantity of water which may be obtained from the distillation of urine in the water-bath ; carried so far as to reduce

ammoniacal and turns the syrup of violets green; that a portion of muriate of ammonia is sublimed, at the end of the operation, and that the coal contains, besides the muriate of soda, phosphate of soda, and lime, and sometimes a little iron.

39 Urine left to itself in a glass vessel at first loses its smell as it cools. That which is highly coloured and sparing, which is voided after violent exercise or when the atmosphere is very hot, beomes turbid throughout its whole extent, and deposits a grey coloured powder. The same phenomenon takes place in the critical urine voided at the termination of diseases; but we are not here to treat of these kinds of urine, but only of that of a healthy person, voided in the morning after sleep, and in the most ordinary circumstances. This liquid at first presents a light cloud which occupies the upper part of it; this cloud gradually augmenting in quantity subsides and becomes a sediment; different kinds of crystals are formed in 24 or 48 hours; there separates at its surface and upon the bottom of the vessel which contains it, small red crystals with brilliant facets: this sand of the urine is uric acid; the urine preserves its acidity as long as these crystals are deposited from it. In some days its colour becomes less intense, its acid nature disappears, it becomes ammoniacal and exhales that smell, and no more uric acid is then deposited, but there is formed at its surface a white, light,

light, and as it were glairy pellicle, in which ſome white priſmatic cryſtals are perceived; the ſame ſalt attaches itſelf every where to the white or coloured cloud which ſwims under the pellicle; theſe cryſtals increaſe in number or in volume during ſix or eight days. Theſe are ſix ſided priſms terminated by pyramids with ſix faces; ſome are tetrahedral with pyramids of four faces. We have found them to be ammoniaco-magneſian phoſphate. This ſalt does not exiſt in the freſh urine; it is depoſited only at the period when the urine has become ammonical. Then, by filtrating the urine at the time when this ſalt no longer increaſes in quantity, we find it to be charged with carbonate of ammonia, turning the ſyrup of violets green, effervefcing with the acids, and affording with the ſulphuric and muriatic acids, after it has been evaporated to the conſiſtence of a ſyrup, a very marked acetous odour, and containing little or none of the cryſtallizable and coloured matter, which has been indicated above, and is extracted from the pure urine by ſtrong evaporation and refrigeration.

40. Thus the ſpontaneous alteration of the urine produces ſeveral important phenomena. The uric acid is firſt depoſited in red cryſtals by mere cooling; the ammonia which is formed ſoon interrupts its ſeparation; theſe are ſucceeded by a white cloud, formed of phoſphate of lime and an albuminous ſubſtance, matters which are no longer ſoluble in the urine after the phoſphoric

phoric acid, which at firſt was free, becomes ſaturated by the firſt portion of ammonia that is formed; the uric acid paſſes into the ſtate of ammoniacal urate and forms part of the cloud; the proportion of the phoſphate of ammonia and that of the ammonia both augmenting, and eſpecially the latter, this unites with the phoſphate of magneſia, and gives riſe to the ammoniaco-magneſian phoſphate, which cryſtallizes. The matter peculiar to the urine, which is converted ſo abundantly into ammonia, forms at the ſame time carbonic acid, which ſaturates the portion of ammonia exceeding the ſaturation of the uric and the phoſphoric acids: and this is the reaſon why the liquor contains ammoniacal carbonate, effervefces with the acids, and even gives this ſalt cryſtallized by the action of a mild fire. At the ſame time acetous acid is developed, which the ammonia alſo ſaturates; ſo that we may obtain ammoniacal acetite by the diſtillation of the urine thus decompoſed. The common ſource of theſe three new compounds, ammonia, carbonic acid and acetous acid, is in the particular matter of the urine, which has already been ſeveral times indicated, and which is eminently ſuſceptible of fermentation; accordingly, the urine when once decompoſed, contains only alkaline phoſphate, and no longer preſents this matter, or at leaſt contains only a very ſmall quantity of it; and it is for the ſame reaſon that it has formerly been ſo much recommended to let the

urine putrefy in order to extract its fusible or native salts. These are obtained both more abundantly and more pure when the urine is exposed to the strong heat of the sun: it keeps a long time without putrefying, becomes concentrated, coloured, and evaporates instead of experiencing the fermentation which quickly establishes itself in the shade.

41. All the urines however do not constantly and indiscriminately present this kind of effectual alteration which entirely changes their intimate nature. In the same individual whose urine presents this decomposition, it frequently happens that this liquid, instead of becoming covered with the saline pellicle, presents at its surface, on the fifth or sixth day after it has been evacuated, a coloured mouldiness after the deposition of the crystals of uric acid and the light white cloud. This mould, which is grey and green, increases during about twenty days; no white prismatic crystals are seen except below the pellicle covered by the mucus, and there they are few. The liquor, instead of being surcharged with carbonate of ammonia, has no ammoniacal smell; on the contrary an acetous emanation is disengaged from it by the muriatic acid; and when it is concentrated by evaporation, we again find in it the particular matter above indicated, and in still greater abundance. Citizen Hallé has well described this state of the urine, which is frequent, and which in the state of health, nearly equals in the number of

of days in which it is met with, that of the days in which the fame liquid prefents a ftrong ammoniacal decompofition. In his Memoir, Citizen Hallé, who has obferved the phenomena above indicated (No. 40,) and from whom we differ only by the more precife appreciation of the matters feparated and of the caufe of their feparation, fince his object was only to defcribe the fenfible phenomena of the fpontaneous alteration of the urines, calls thofe *acefcent* which comport themfelves as has here been faid, and has not neglected to mention the mouldinefs which conftantly accompanies them. We have found that thefe urines, which are lefs alterable and lefs decompofable, contain lefs albuminous fubftance than the preceding; whence we have concluded that the fpeedy alcalefcence depends upon the prefence of this albumen which is actually exhibited in them by means of tannin; for its folution precipitates the highly putrefiable urines much more abundantly than thofe which are but flightly fo. Thus we have two kinds of urine which each individual appears to void alternately or in different circumftances which have not yet been afcertained.

42. Urine unites with water in all proportions and is conftantly mifcible with it; the water diminifhes its denfity and weakens its colour; it diminifhes the vifcidity of that which poffeffes this character: it diffolves or at leaft divides the glairy filaments which are fome-

times found in it; it causes that which has an intense colour to pass into the lemon-yellow, and gives to the inflammatory and ardent urine the tinge of the urine of perfect health, as has long ago been remarked by Bellini. The acids have no action upon fresh urine; the oxalic only forms in it a precipitate of oxalate of lime, by decomposing the calcareous phosphate which it constantly contains: this is a means of determining the proportion of lime, and consequently of calcareous phosphate, which it holds in solution. All the acids produce effervescence with putrefied urine, on account of the carbonate of ammonia which it then contains in abundance. In urine, pretty strongly concentrated, the muriatic acid sometimes forms a precipitate of benzoic acid, and the nitric acid, a little concentrated, suddenly produces in it white crystals, of a pearly brilliancy, in great abundance, by uniting with the urinary matter which I have several times announced, and of which I shall soon treat in particular. When the urine is much putrefied, the nitric acid does not produce these crystals; the oxiginated muriatic acids discolours and whitens the urine. Most of the acids, especially the sulphuric, which when it is poured, concentrated upon the freshest urine, turns it brown, and it carbonates, gives a rose or red colour to all the ammonical products that are extracted from this liquid by distillation.

 43. Almost

43. Almoſt all the earthy and alkaline matters exert a more or leſs decompoſing action upon urine. It has long been known that when lime or alkalies are thrown upon it, a fetid ammoniacal odour is developed; which proceeds not only from the decompoſition of the phoſphate of ammonia, but alſo from the action of theſe baſes upon the urinary animal matter. The ſolutions of barites, of ſtrontian, and of lime poured into the urine, immediately form a precipitate in it; the two firſt ſeparate the phoſphate of lime from it, abſorb the phoſphoric acid which held it in ſolution, and precipitate the phoſphate of barites or of ſtrontian, which unites with the acid. This phoſphate proceeds either from the union of the earths with the free phoſphoric acid, or from the combination of the barites with the acid engaged in the ſoda, the ammonia and the magneſia: ſo that the barites decompoſes all the phoſphoric ſalts contained in the urine. The ſulphate of barites is depoſited when there is any ſulphate of ſoda in the urine.

Lime, whilſt it effects the ſame decompoſitions, precipitates only the phoſphate of lime, either that which exiſts ready formed in the urine, or that which the addition of this earth determines with the free phoſphoric acid, and the magneſia united with the acid, without touching the other ſalts. When the fixed alkalies are poured in exceſs into very recent urine, beſides the

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action already indicated, they prevent the uric acid from depositing itself, and retain it in solution. Ammonia does not produce the same effect. Amongst the salts, only the nitrates and the muriates of barites, of strontian, and of lime, produce precipitations by decomposing the phosphates. The muriates of soda and of ammonia, dissolved in cold urine to saturation, and afterwards exposed to spontaneous evaporation in the sun, crystallize with a very remarkable modification of their form. The first, instead of the cubic which it ought to have, assumes the octahedral form; and the second, from the octahedral form, passes into the cubic. We shall soon see the cause of this singular modification.

44. Some metals amongst those that are the most combustible, the most greedy of oxigen, are oxided by the contact of urine, and are converted into phosphate by remaining in this liquid, with the aid of the free phosphoric acid which is contained in it. Citizen Vauquelin has observed, that the bars of iron with which the walls are supported in places appropriated for making water, constantly present this metal corroded, frequently in brittle scales, in grey or brown oxide, often swelled and filled with brilliant crystals. These brittle layers, when separated and lixiviated in water, give alkaline phosphates; and their undissolved portion, heated strongly in a crucible with charcoal, affords a well fused phosphuret of

 iron,

iron, ſpherical, brittle, of a brilliant grey colour and granulated, which proves that this portion was phoſphate of iron. It is neceſſary, therefore, when this metal is to be expoſed to the contact of the urine, to cover it with a coating which may defend it againſt the action of the ſaline part of this animal liquid. There is reaſon to believe, though it has not yet been tried, that ſeveral other metals, eſpecially zinc, tin, lead, and copper, are ſuſceptible of being acted upon in the ſame manner by the urine.

Many metallic ſalts, particularly the nitrates of mercury, of lead, of ſilver, of zinc, &c. produce, when their ſolutions are poured into urine, a very abundant precipitate, conſiſting of phoſphates and muriates. One of them, that of mercury, has been known more than a hundred years ago, by the name of *roſe coloured precipitate*, and recommended by Lemery for medicinal uſe. Collected upon a filtre and dried, it preſents phoſphoreſcent ſcintillations when it is detached or rubbed in the dark. Heated in a cloſe veſſel, part riſes in muriate of mercury; another part, when a ſtrong heat is applied, gives phoſphoric and luminous vapours. This is a very ſimple and commodious proceſs for obtaining this combuſtible body; and it is far preferable to the very diſagreeable evaporation of the urine, and to the treatment of its extract by diſtillation with charcoal.

45. Only four kinds of vegetable matters are employed with advantage for the analyſis

of the urine: the oxalic acid, which precipitates the lime from it in an infoluble oxalate, and enables us to determine its quantity; the light blue colouring fubftances, namely, of turnfole, of mallows, which are reddened by this liquid, and which announce an acidity; tannin, which feparates the albuminous or gelatinous matter in infoluble fawn-coloured flakes, and may ferve for eftimating the precipitation of this fubftance evacuated by the excremental liquid; and laftly, well rectified alcohol; this effects a kind of parting operation in the urine, by precipitating the uric acid, the phofphates, and moft of the faline matters, which have lefs attraction for water than the alcohol has, whilft it retains in folution the more abundant urinary fubftance, with the muriate of ammonia, and partion of the muriate of foda. This laft re-agent may efpecially be employed upon urine concentrated either by congelation or by evaporation, and we have feen above, that alcohol ferves us for obtaining this urinary matter feparated from all the other materials of the urine. No animal fubftance is employed for the analyfis of the urine, and nothing is yet known relative to the action which the different animal liquids or folids are capable of exercifing upon it; we have even been frequently embarraffed in medicine to decide upon the nature of fome mixtures of different animal fubftances with the urine, mixtures which fometimes prefent themfelves,

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and of which it is difficult to estimate the characters with accuracy. Thus it is frequently uncertain whether the urine contains blood, glairy matter, pus, milk, bile, which physicians frequently admit in it, without having adopted any certain means for determining with precision any of these mixtures. In this kind of research I know only one experiment inserted in the Philosophical Transactions of the year 1790, No. 21, in which Dr. Everard Home has ascertained that blood mixed while hot with urine coagulates into a mass, which, when steeped in urine, changed three times in 24 hours, imparts a red tinge to it during fifteen days, and afterwards is detached in white flakes, which deposited, are in sediments of the same colour; hence he has concluded that the blood, which does not become altered or putrefied in these circumstances, comports itself as when it is voided out of the bladder with the urine.

46. From all that has been said concerning the action of different bodies upon the urine, it results that the analysis of this liquid becomes singularly complicated by the means even that are employed for making it; that the multiplicity of principles which are contained in it, cause the nature of the materials which are extracted from it, to vary in a multitude of circumstances; that unless we constantly keep in mind the alterability of which the urine is susceptible, we may fall into great errors respecting the appreciation of these materials;

terials; that in particular the action of fire, which has so often been employed for its analysis, produces an alteration which changes the properties of most of its principles, even though it be applied in the most judicious and gradual manner possible: and that it would be still more important to find for this kind of analysis, than even for that of certain mineral waters, means capable of enabling us to ascertain its component principles, without changing its properties and composition. Such especially would be those re-agents, which at the very moment of their admixture with the urine, would each announce, without error or ambiguity, and by an effect equally sensible and constant, one of the principles which form a part of it. Unfortunately, those which have hitherto been discovered, indicate as yet only the smallest part of these principles: we are therefore obliged to combine several processes together, the results and the effects of which, when compared together, operate in such a manner as to leave no doubt respecting the matter which they announce. Thus the spontaneous evaporation, that by the fire, the fermentescible alteration, the action of alcohol upon the residuum of a gentle evaporation, and the phenomena produced by different re-agents combined in their results, afford at last an exact knowledge of the principles which constitute the urine, as I have shown, and conduct us, as I shall show to the

particular

particular examination of its different materials, and to the better determination of what this urinary liquid really is.

SECTION V.

Of the Matters contained in the Human Urine, individually confidered.

47. WHEN we feek a general refult of all the analytical facts fet forth in the preceding paragraph, and of all the phenomena which the chemical properties of the urine prefent, we find that the urine is not merely a faline ley, as has hitherto been afferted, but a folution of a great number of different matters, amongft which the faline fubftances occupy the leaft place. If we wifh to form a faithful reprefentation of all the kinds of analyfis to which this liquid has been fubjected, and of the notions which it has afforded to the authors, who have confidered it under different points of view,—we fhall foon feel the neceffity of paffing in review all the poffible matters which chemifts have hitherto indicated in the urine, of afterwards reducing the number of thefe matters to fuch as are conftant, and may be confidered as its true principles, fince they are always met within it in their natural ftate; of

of confidering, in the third place, fuch of thefe principles as are but feldom found in it, and are accidental to it; of paffing from thence to the examination of thofe that are only hypothetical, and have been admitted in it without having been proved; and laftly, of examining the modified ftate and nature of the conftant principles in the urine fpontaneoufly altered.

48. I find, according to all the analyfes hitherto collected, that chemifts have admitted in the urine, either in the natural ftate, or in any ftate of alteration, whether they have well proved their exiftence, or have adopted them lightly, or even announced them hypothetically, thirty matters different from each other, befides the water which forms their vehicle, viz. 1, muriate of foda; 2, muriate of pot-afh; 3, muriate of ammonia; 4, fulphate of foda; 5, fulphate of lime; 6, phofphate of foda; 7, phofphate of ammonia; 8, phofphate of lime; 9, phofphate of magnefia; 10, triple phofphate of foda and of ammonia; 11, triple phofphate of magnefia and of of ammonia; 12, free phofphoric acid; 13, uric acid; 14, benzoic acid; 15, acetous acid; 16, a particular acid different from all that are known; 17, urate of ammonia; 18, benzoate of ammonia; 19, acetite of ammonia; 20, carbonate of ammonia; 21, oxalate of lime; 22, a colouring matter; 23, an odorous principle; 24, albumen; 25, gelatin; 26, an extract; 27, faccharine matter; 28, an attenuated oil; 29, filex; 30, laftly

laftly, a body peculiar to this excremental liquid, which is the moft abundant of all its principles. Each of thefe matters muft be confidered fingly, in order to arrive at an exact notion of the nature of the urine, by examining whether it actually exifts in it; how it has been difcovered; in what ftate it is met with; the function which it performs; or the reafon why it has been admitted without pofitive proof, &c.

49. The muriate of foda was the firft faline matter known to exift in the urine: it was long believed that it formed its principal part, and gave moft marked character. Stahl even went fo far as to fay, that the production of the phofphorous that is obtained from it was owing to this falt It actually exifts in it; it is extracted either by evaporating the urine by fire; whereby it is fometimes collected at the furface in fmall cryftals, or at the bottom of this liquid by fpontaneous evaporation, or amongft the mixed cryftals of fufible falt, or of phofphates, obtained by the refrigeration of the urine evaporated to the confiftence of a fyrup. To it, is in part to be afcribed the precipitation of the urine by the nitrates of white metals. Chemifts may have hitherto deceived themfelves refpecting its nature and its proportion, fince when it is extracted by a flow evaporation, it affumes the form of octahedrons, inftead of that of cubes, which it affects when it is pure.

50. The

50. The muriate of pot-ash, which has been announced by Rouelle, is pretty frequently contained in the urine, but it does not exist in it so constantly as the preceding; however it does not seem to be in some measure so necessary in its constitution as the preceding. In the confused crystallizations of the salts of the urine, we do not distinguish it from the other saline matters in the mass of which it is confounded; it is especially confounded with the muriate of soda which it accompanies, and the effects of which it imitates in the action of re-agents. There is reason to believe that its form is modified by the urinary matter like that of the muriate of soda, though we have no direct experiments upon this subject. This salt is obtained insulated and well distinguishable only by purifying with care, and at several successive times, the mixed saline masses, produced by the crystallization and refrigeration, and destroying by calcination the brown or black animal substance which soils them and impedes their separation. It is by a slow and patient labour upon the purification of these mixtures that we succeed in effecting it. It most frequently seems to form one of the accessary or accidental matters, and not one of the really constituent materials of the urinary liquid.

51. The muriate of ammonia has long been acknowledged in the urine by chemists; they have even formerly attributed its source

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or origin to this liquid, as alſo to the excrements of the animals. Rouelle the younger, however, was almoſt tempted to deny its exiſtence, or at leaſt he doubted of it. This aroſe from two circumſtances, which, even whilſt they announce the accuracy of the experiments of this able analyſt, depended only upon his ignorance of the influence exerted upon this ſalt, by the urinary matter properly ſo called, which is the moſt abundant of all. This matter not only envelopes and prevents the ſeparation of the muriate of ammonia which is always found to accompany it, and cannot be detached from it without difficulty, but it alſo adheres ſo ſtrongly to it, that alcohol diſſolves the muriate of ammonia at the ſame time with this matter. The greater part of this ſalt is therefore found only by long labour, and it can hardly be obtained ſeparate till after the decompoſition of the laſt urinary matter; thus it is diſengaged and ſublimed only at the end of the diſtillation of the extract of urine. A ſecond circumſtance which may have impoſed upon Rouelle is that the muriate of ammonia cannot be obtained from the urine, as long as it contains the matter of which I here ſpeak, except in the form of cubical cryſtals which muſt have been taken for muriate of ſoda.

52. The ſulphate of ſoda has been announced in the human urine by Rouelle the younger. He even attached a certain value to this diſcovery, for in a particular inquiry reſpecting this liquid,

liquid, publiſhed in 1773, he took care to mention that he had already extracted this ſalt, and had exhibited it publicly, in 1770, in his courſe of Lectures at the Muſeum of Natural Hiſtory. It muſt be remarked that other chemiſts have ſpoken of it before him, but have given no proceſs for extracting it. Not having found this ſalt in a ſufficiently clear manner in the urine, I have reaſon to think that Rouelle may have been deceived, either by the phoſphate of ſoda, or, which is ſtill more probably, by the ammoniaco-magneſian phoſphate, the form and appearance of which ſufficiently reſemble thoſe of the ſulphate of ſoda, for its preſence, very unexpected at the already diſtant period of this inquiry, to have been likely to eſcape him.

53. Several chemiſts, as well as the laſt-mentioned, have alſo announced the ſulphate of lime in the urine. They have manifeſtly been led into an error by the calcareous phoſphate, the preſence of which in the animal matter was unknown in France till in the year 1775, eſpecially in the urine. This is the more probable, as it was only after the white, earthy, inſipid, inſoluble depoſition, which is formed in the courſe of the evaporation of the urine, and was ſeparated from it, either by decantation, or by filtration in order to obtain the ſalts pure, that theſe chemiſts admitted its preſence. Now it is at preſent known that theſe characters are found in the phoſphate of lime, and that

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this is the salt which separates from the urine at the first formation of the ammonia.

54. The phosphate of soda is one of the most important and best known salts of the urine; being confounded for a considerable time with the phosphate of ammonia under the name of *microcosmic or fusible salt*, it was suspected by Pott and Magraff; was well separated from the above mentioned salt by Haupt, Schlosser, Rouelle, &c. well analysed by the latter, and by Westrumb and Klaproth. It is very remarkable at first by its property of not affording phosphorous, and of remaining in the residuum of the distillation by which this combustible body is obtained; it was afterwards recognized as acting in the urine upon the metallic solutions which were poured into it, constituting a great part of the precipitate which these solutions form in it, and becoming, in this form, susceptible of affording phosphorus with charcoal.

55. The phosphate of ammonia is one of the best known and best proved salts of the urine; it is that which beyond all the others has been the most examined, and has served with the most advantage to characterize this liquid, since it is from it that the phosphorus of urine was extracted. It is rarely obtained alone, though it tends to crystallize first after the inspissation, and by the refrigeration of the urine. It is always mixed with a certain quantity of phosphate of soda, and appears even to form

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with it a kind of triple ſalt, which conſtitutes the baſe of the native, fuſible, or mircrocoſmic ſalt. It is very diſtinguiſhable, when pure and inſulated, by its property of affording ammonia by the action of fire, and of leaving phoſphorous acid which may be obtained in the form of a tranſparent acid, ſoluble and deliqueſcent glaſs.

56. The phoſphate of lime was diſcovered in urine by Scheele, in 1775; it had formerly been taken for a gypſeous matter; it was afterwards ſpoken of as real ſulphate of lime. Some good medical obſervers having ſeen it precipitated very abundantly from the urine in the affections of the bones, ſuſpected it to be formed by the oſſeous matter; but being ignorant of the nature of this matter, they equally miſtook that of the phoſphate of lime in the urine. Scheele had moreover found that it was diſſolved in it by means of an exceſs of phoſphoric acid: and Citizen Vauquelin and myſelf, in our particular inquires, have added to this diſcovery, that this earthy ſalt was precipitated ſpontaneouſly from the urine, when this liquid preſented, in the firſt moments of its alteration, a production of ammonia, which ſeizing upon the exceſs of acid, rendered the phoſphate of lime inſoluble. The ſame effect is produced by the action of fire, and it is on this account that urine becomes ſo turbid during its evaporation. It is in part the cauſe of the

the precipitation of the urine produced by lime water, ammonia, the oxalic acid, &c.

57. The phosphate of magnesia had not been indicated in the urine previous to our inquiry; we were led to seek it by the discovery of this salt in some kinds of urinary calculi. Indeed we have found it insulated and pure only in very fresh urine; it is in part the cause of the precipitates formed in this liquor by lime-water, ammonia, the caustic fixed alkalies, barites, strontian. It is constantly found mixed with calcareous salts in the precipitates, and when we suffer them to macerate for some time in dilute sulphuric acid, the liquid portion being decanted and evaporated spontaneously, affords very pronounced crystals of sulphate of magnesia. It has not hitherto been possible to obtain it separate from the other salts of the urine, either because it mixes with several of them during their crystallization, or because the action of the fire forms ammonia, which unites with it and forms a triple salt. It is precipitated with most of the preceding, excepting the muriate of ammonia, when well rectified alcohol is poured into the fresh urine.

58. As to the triple phosphate of soda and of ammonia, announced as the tenth of the principles hitherto discovered or admitted in the urine, I have already said (No. 55) that this salt commonly exists in the aggregate or the mass of crystals which are obtained by the refrigeration and repose of the inspissated urine under

ler the names of *fusible salt, native salt of* *ne, microcosmic salt.* The attentive examina-
i which I made in 1790 of this entire proved to me that by re-dissolving and ing it to crystallize several times in succ- on, in order to purify it, crystals of this e salt were obtained, composed of different ortions of the two primitive salts; so that irst contained much more phosphate of am- a, and the last much more phosphate da; insomuch that at the end of this ication, the phosphate of soda crystallized , as had been observed by Haupt, Rou- nd even Margraff and Pott before them. e are therefore several varieties of this triple which cannot be ascertained and deter- d except by an exact analysis. There is a er quantity in putrefied than in fresh , on account of the formation of am- a, which saturates that portion of phos- c acid which holds the phosphate of lime lution.

. The triple phosphate of magnesia and of onia does not exist in fresh urine, the hate of ammonia it contains, which ap- to be combined with the phosphate oda: whence it seems to follow, that mmoniacal phosphate has more attraction hat of soda than for that of magnesia. ever as a great number of urinary calculi und to contain this ammoniaco-magnesian hate, we have been induced to enquire

how this could be formed in the urine, and we have difcovered that it is produced when the ammonia is itfelf formed in fufficient abundance to faturate all the free phofphoric acid of this liquid, and the excefs of phofphate of ammonia thus decompofed feizes upon the fulphate of magnefia. In this cafe, the ammoniaco-magnefian phofphate becoming, like all the triple falts of the fame nature, lefs foluble than each of its two component falts were feparately, feparates from the urinary liquid and tends to cryftallize; as is frequently feen in the fpathofe white layers of fome calculi. Such is the origin of the elongated prifmatic white cryftals, which are feen to depofit themfelves in urine that has been kept for fome days, both upon the fides of the veffels which contain it, and under the cruft which then covers this liquid.

90. The free phofphoric acid of urine was really difcovered by Scheele, when he obferved that the phofphate of lime was diffolved only by means of this acid. Citizen Berthollet paid much more attention to the prefence of this acid than Scheele had done, who had indicated it, if I may ufe the expreffion, only tranfiently. Several phyficians had long before perceived the natural acidity of the urine. Col. de Villars had efpecially announced it in his courfe of furgery; and neverthelefs it was a generally received opinion that the urine was of an alkaline nature. The embarraffment

taffment in which the chemifts found themfelves in this refpect, proves that they did not diftinguifh the tendency to alkalefcence by which this liquid is characterized, from its truly and conftantly acidulous nature at the moment when it is evacuated out of the human body. It is to the phofphoric acid, as the ftrongeft and moft powerful of thofe that are found diffolved in the urine, that this acidity is to be afcribed; but we muft not fuppofe it to be pure and infulated, fince it is engaged in a real combination with the phofphate of lime which it renders foluble. It muft be conceived, on the contrary, that were this acid pure and without calcareous phofphate, the urine would be much more acid. We have already feen that this portion of acidity is deftroyed by the firft formation of ammonia, and that it is then that the phofphate of lime, ceafing to be foluble after this faturation, is depofited, and renders the urine turbid in proportion as it abandons it; the urine, therefore, is an evacuant of phofphoric acid in excefs.

61. The uric acid is one of the moft fingular and ufeful difcoveries of Scheele. After having found it in the calculus, or ftone of the bladder, he difcovered it in all kinds of human urine; he obferved it to be precipitated by the cooling of this liquid, and to form what is known by the name of fand; it is this which produces thofe cryftals of a reddifh or light ruby colour, which depofit themfelves upon

the ſides of the veſſels in which the urine is re ceived. It is to it that Scheele attributes th grey or peach-bloſſom coloured precipitation of the critical urine at the termination of diſ-eaſes. It undoubtedly contributes to the acidity of this liquid, though its own be but extremely weak. Being one of the leaſt ſoluble principles of this kind of animal lixivium, it is ſepara-ted firſt from its natural ſolvent, in which it is more ſoluble when hot than when cold, and which it abandons by the mere diminution of its temperature. As a particular animal production, we ſhall ſee, in the following article, that it poſſeſſes very diſtinctive characters, and forms one of the moſt frequent materials of th urinary concretions.

62. Scheele is likewiſe the author of the diſ covery of the benzoic acid in urine ; for Rouell the younger who had found in it that of the co and of the camel, had not ſufficiently diſtinguiſh ed it to aſcertain its nature, as the Swediſh chemi does. We have met with it in all urines, an Scheele had eſpecially admitted in that of in fants. It ſometimes ſublimed from the extra of this liquid when acted upon by a ſtrong fire it may alſo be precipitated from it after its eva poration and concentration. There is reaſon t believe that it proceeds from the aliments, eſ pecially in the mammalia where it exiſts mos abundantly. Its preſence in the urine of in fants, who ſubſiſt only upon the milk of thei nurſes, however renders this opinion leſs ad

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fible, and affords ground to fuppofe that formed in the bodies of the animals. It is ittle abundant and fo much diluted in the e of adults, that it is not eafy to reckon it ngft the caufes of its acidity; it is fcarcely than an acceffary matter, indifferent ıe quality of this liquid, and yet found antly enough to prove that its excretion his emunctory enters into the plan of re.

The acetous acid does not naturally exift in urine. Though difcovered, nearly fifty ago, by Pott amongft the diftilled products is liquid. Chemifts have not fpoken of it Citizen Vauquelin and myfelf, in our feries of experiments upon the urine, have ained that it is conftantly formed by the ntation which takes place in it; that nftituent materials conftantly exift in it; it is the product of its firft alteration; ıat it accompanies the production of am-. We muft not conclude from hence, Van Helmont, that urine is fufceptible of iencing the vinous fermentation, or of ing ardent fpirit; which was denied with juftice by Boerhaave, though, as we fhall reafter, there are fome cafes in which this ty may be found in it. It is now fuffi-y known that the previous formation and ce of alcohol are not always immediately ary to the production of the acetous acid, ıat it is formed in many circumftances which

which have nothing to do with the alcoho fermentation.

64. Profeſſor Scherer, of Jena, in a letter Citizen Van Mons, written in the middle the year 1797, ſpeaks of the experiments Dr. Gaertner, of Calw, in Swabia, upon tl urine, and of an acid peculiar to this liqui This phyſician thought he had found, after rigorous examination of this evacuation, th the acid of the urine, which he had taken firſt for phoſphoric acid, had other properties i which it differed from it, as well as from a other known acids. According to him, th acid is volatile, and ſublimes by a ſtrong heat; tl ſulphuric, nitric, and muriatic acids, precipita it from its ſaline combinations, partly in the for of gas, partly in that of a fixed acid which b evaporation affords ſcales unalterable by tl air and odorous. Though theſe experiments a little extended and multiplied, they howev lead me to conclude that Dr. Gaertner has co founded, in his reſearches, the benzoic aci with ſeveral of the phenomena produced by th particular urinary matter, with which I ſha ſoon occupy myſelf, and that it is in theſe tw ſubſtances that he has imagined he had found new acid different from all that are known. therefore conſider his new acid as an imaginar ſubſtance, and his experiments as in no reſpe invalidating the preſence of the three acids, tl phoſphoric, the uric, and the benzoic, inſulate

or in part free in well conftituted urine, when frefh and recently voided.

65. The urate of ammonia had not been indicated in the urine previous to our laft refearches. After having difcovered it in fome calculi of the human bladder, we convinced ourfelves that it exifted in putrefied urine. When ammonia is produced in it in fufficient abundance to faturate all the phofphoric acid and precipitated the earthy falts, the excefs of this alkali feizes the uric acid, faturates it and forms that falt which depofits itfelf, becaufe little foluble, above the phofphate, and has a light fawn colour. This falt is well characterized and very diftinguifhable by its folubility in the leys of the cauftic fixed alkalies, and by the very abundant difengagement of ammonia which accompanies its folution in thofe reagents. The urate of ammonia exifts therefore only in altered urine, and is not natural in this liquid.

66. The benzoate of ammonia is in the fame predicament with the foregoing; it is not contained in recent urine; it is only found in this liquid after it has undergone that fermentation which changes its nature: it is formed only at the expense of the ammonia, one of the conftant and moft abundant products of this fermentation by which its nature is changed; and when its quantity is fufficiently confiderable to faturate at once the phofphoric acid, the uric acid, and the benzoic acid of the urine. Thus, in the advanced

advanced putrefaction of this liquid, the benzoic acid is no more free in it, but entirely saturated with ammonia, and at this period it would be in vain to seek it in its pure state. In order to obtain it in this state, it would then be requisite to separate it from this alkali. It is in this manner that strongly evaporated urine, in which the heat has promoted, at the same time with the putrefaction, the formation of the ammonia, gives, by the addition of the muriatic acid a precipitate, always sensible and sometimes very abundant, of benzoic acid in small scales. The nitric acid must not be employed for this purpose; for this would cause to be precipitated with the benzoic acid, another crystalline matter infinitely more abundant, which would entirely disguise it. It is this undoubtedly which deceived Dr. Gaertner, when he thought he had separated a particular acid from the urine: he may indeed have obtained a body different from all others; but this was not an acid, as I shall soon show more in detail.

67. The acetite of ammonia exists, according to our experiments, in fermented urine As this particular fermentation consists in the simultaneous formation of ammonia and of acetous acid, and as the first of these productions is infinitely more abundant than the second, it is evident that the acetous acid cannot exist free and insulated in the urine, but combined with ammonia. It is undoubtedly on account of this saturation, which takes plac

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as ſpeedily as the formation of the urinary acetous acid, that this acid has ſo long eſcaped the chemiſts, who, in fact, were almoſt entirely ignorant of it before us. It is on this account that when altered urine is diſtilled, water is obtained from it which contains ammoniacal acetite, or *Spiritus Mindereri.* It is alſo on the ſame account that when we wiſh to obtain pure acetous acid from the fermented urine, it is neceſſary to diſtil it with the addition of ſulphuric or muriatic acid. It is unneceſſary to remark that this ſaline combination, ſo far from being one of the conſtituent elements of the urine, is, on the contrary, that product which indicates the moſt profound alteration of that liquid.

68. The carbonate of ammonia has long been known as one of the matters that are extracted, the moſt eaſily and the moſt abundantly from urine. Haller was even aſtoniſhed that this liquid was not preferred to many other animal ſubſtances for the preparation of this ſalt, which has been known for nearly two centuries by the name of volatile ſalt of urine. It is not however one of the true materials of this liquid; it exiſts in it only when the urine has undergone a great and effectual alteration; when, in the laſt periods of its decompoſition, the very abundant ammonia has ſaturated the phoſphoric, uric, benzoic, and acetous acids; when the latter acid, being formed as abundantly as poſſible, leaves the carbon and the oxigen ſufficiently inſulated

infulated from the other conftituent elements of the urine, and fufficiently approached to each other to unite by their binary attraction, whilft the ammonia, always continuing to be produced, faturates and fixes this acid, becomes fixed itfelf, as faft as it is produced. Thus the carbonate of ammonia is the laft term, and as it were the laft teftimony of the decompofition of the urinary animal compounds. At the end of the putrefaction of the urine it is fo abundant in it that it ftrongly turns the fyrup of violets green; that it produces a brifk effervefcence with the acids; and that by the mildeft fire, even on the water-bath, it affords by a well conducted diftillation, both water charged with carbonate of ammonia, and carbonate of ammonia in fublimed cryftals: accordingly it is employed with advantage in feveral works for procuring this falt.

69. Though Citizen Vauquelin and myfelf firft found and indicated the prefence of the oxalate of lime in the kinds of urinary calculi known by the name of mural or muriform; we have not yet been able to find this falt, either infoluble or foluble only by the aid of fome acids in the human urine. It does not appear to form one of its conftituent materials in its natural ftate; but to be contained in it only in fome particular morbid circumftances. In fact, it is eafily conceived that if, by any caufe, oxalic acid is formed, either immediately in the urine, or in other fituations, and if, in the

latter

atter case, it be transported into the kidneys; his acid must immediately decompose the phosphate of lime, which naturally exists in it, nd form a calcareous oxalate, which is hardly luble in the excess of phosphoric acid. Acordingly it is not allowable to conceive the esence of the oxalate of lime unless we at e same time, suppose the absence of the osphate of the same base, or at least we nnot admit the first unless in so small quantity, ppofing it to be found along with the second, at it can then be scarcely appreciable. One my pupils, however, assures me, that he has tely found this salt abundantly precipitated the urine of an infant afflicted with an helintic disease, under which he perished. I all speak of it again in one of the subsequent imbers.

70. Some chemists have admitted a particular louring matter in the urine, induced by the ways particular, and sometimes very remarkable louration of this liquor. No one, however, has curately proved its existence. It has been prended, in several medical theories, that this louring part was bile, and Boerhaave had ccessfully combatted this opinion at the ommencement of the present century. Rouelle e younger, first placed this matter in its true ght, by showing that the colour of the urine as owing to an extractive substance, respecting the nature of which it was difficult for im then to conceive an exact notion, but with some

ſome of the moſt ſingular properties of whi he was evidently acquainted. We ſhall ſ hereafter that, without admitting a particul colouring principle in the urine, it is to t matter which eſpecially characterizes this liqui which forms its moſt abundant conſtituent par and which gives it the moſt of its diſtinctiv properties, that its colour is to be aſcribed and this matter is, as we ſhall ſee, one of thoſ which Rouelle called extractive. Its propor tion which is very variable with reſpect to tha of the water which holds it in ſolution eſtabliſhes the principal differences which exiſ in the different urines, ſince, according to th ingenious remark of Bellini, we may, witl highly coloured and concentrated urine, an water added in different proportions, imitate al the varieties of colour which this liquid is capa ble of preſenting, according to a multitude o circumſtances.

71. The ſame is to be ſaid concerning th odorous principle of the urine. Howeve peculiar to this humour, however diſtinct an characterized it may be as an individual odou belonging to no other known matter, reſem bling a kind of aromatic and even ſtrongl aromatic exhalation, it is unneceſſary in orde to explain it, to admit a particular odorous prin ciple in the urine. Its ſource is found in th ſubſtance which gives it its colour, and whic truly conſtitutes the urine by all its propertie This odour is ſo fugitive, ſo little durable, th

it can ſcarcely be ſeized except at the very moment when the very pure, and very healthy urine is voided from the bladder; it is very perceptible in hot urine, but is weakened and diſappears almoſt entirely in this liquid when it has cooled; and it becomes quickly altered from the firſt period of the decompoſition which ſo ſoon takes place in the urine, and it is ſuſceptible of a great variety of modifications from many accidental circumſtances. It becomes fetid by the uſe of aſparagus or cantharides; it is rendered acrid by the marine aliments, fiſh, the teſtacea; pleaſant and analogous to that of violets by turpentine, the reſins, the balſams, and ſeveral gum-reſins. It unites with that of garlic, of the vegetable acids, of camphor, of ſulphur, &c. &c.

72. No chemiſt has yet aſcertained with preciſion the preſence of the albuminous matter in the urine. It is to Citizen Seguin that we owe the firſt notion of it, in his reſearches upon tanning; he firſt remarked that a ſolution of tan poured into the urine, produced in it a very varied precipitate, according to the different ſtates of the ſubject; he has even ſuſpected that this teſt by tannin, might be of utility in medicine, for announcing the proportion of nutritious ſubſtance that paſſed off by this excretion. But he has not explained himſelf accurately, reſpecting the nature of this ſubſtance, and it is by our ſucceſſive experiments that if not poſitively aſcertained, at leaſt, we have begun

gun to prove that the albuminous matt may fometimes be evacuated by the urine a form part of this liquid. We have not, howev obtained it feparate, we have not been al to infulate it fufficiently and obtain a fufficie quantity of it, to determine its nature wi certainty: it does not appear, fuppofing it t exift in it in fome preter-natural cafes, that conftantly forms part of the urinary liqui or that it can be reckoned amongft the num ber of its true principles.

73. It is rather to the gelatinous fubftanc to a true gelatin, that the obfervation c Citizen Seguin of which I have juft fpoke applies; for it is known that his experiment upon the precipitation of the animal matter b tannin, and upon this unalterable and imputre cible tanned combination, are efpecially re lative to the gelatinous fubftance, as he ha particularly infifted upon this very mark pro perly in the folution of glue. In announcin therefore the effect of tannin upon urine, an the indication of its ftate by this effect, it wi accord better with the confequence of his di coveries to attribute its caufe to a gelatino matter. Befides, the exiftence of the gelati in the urine correfponds better with the fre quently vifcid and mucous ftate which th liquid prefents in a multitude of circumftance as well as with the glairy flakes or filament which fo frequently fwim in it, or are precipita ted from it, efpecially in certain affections of th bladde

bladder. It is even ſcarcely to be doubted that this gelatin exiſts in the urine here mentioned; but the queſtion is to know whether this matter be conſtantly contained in it? whether it form one of its ordinary materials? whether it exiſts in the natural ſtate? in a word, whether urine of the ordinary limpidity or more limpid than ordinary contain amongſt its principles the gelatinous ſubſtance? It has sometimes been obſerved that urine, after having been evaporated, and after having furniſhed the greater part of its ſalts, aſſumed a viſcous form; it has even been obſerved to become fixed in a maſs; but this property depends much more upon the matter which is peculiar to it, and of which we ſhall ſoon treat. It is not therefore by this property that the exiſtence of the gelatin can be aſcertained, and we muſt only have regard to the precipitate formed by the tannin. Under this relation, moſt urines afford only a ſlight precipitation, and that not ſufficiently ſenſible to authorize us to conſider the preſence of the gelatine as demonſtrated, at leaſt not as conſtant.

74. An extract peculiar to the urine was admitted by Rouelle, the younger, who conſidered it as the cauſe of its colour. He carefully diſtinguiſhed it from the ſaponaceous matter, as well from another extract which he deſignated by the name of ſaponaceous. He deſcribed it as a coloured, brown matter, ſufficiently acrid and ſapid, ſoluble in water, but not in alcohol, ſuſceptible

fusceptible of affuming and preferving the dry form, and eafily feparated by that means from the faponaceous matter. Though I cannot deny the exiftence of this extractive body in the urine, I fhall however remark, that it is not obtained either fo eafily or fo abundantly as Rouelle has afferted; that it is not an extract to be compared with that which is fo called in the vegetables. This principle, admitted by the French chemift, muft not be confounded with the entire product of the evaporated urine, which is defignated by the name of extract of urine, and is a mixture of a great number of different matters, efpecially of faline fubftances, enveloped and every where covered with the matter peculiar to this liquid. Rouelle carefully diftinguifhed the extract of which I here fpeak from all the other materials of the urine, and did not underftand by this name the entire product of the evaporated urine. For the reft, fince his experiments no chemift has fpoken again of this principle, which muft be ranked amongft thefe which I call hypothetical.

75. Sometimes a faccharine matter has been found in the urine, efpecially in a kind of diabetes or urinary flux, which on that account is called the *diabetes mellitus*, or the faccharine diabetes. In England efpecially the extraction of a fort of faccharine body from the urine of diabetic patients, has been the object of the labours of feveral phyficians. I fhall fpeak more in detail concerning it in one of the fubfequent

ragraphs; it is evident that the object in
estion is not a common or ordinary principle
the urine, since it is not in the natural state
it this saccharine matter is found, which
only the product of a morbid alteration.
is body must therefore be ranked amongst
fortuitous or accidental materials of the
ne, not amongst those which constitute or
racterize it. This is so true, that when it
sts in it, the liquid voided from the bladder
no longer what it ought to be in the state of
lth; it is no longer real urine which is dis-
rged; it is neither the same fluid which is
cuated, nor the same excrement that is
ded, nor the same function that is performed.
h is even the general notion which we ought
orm of the renal evacuation so changed or
lified by diseases, as no longer to possess the
racter which properly belongs to it, and no
ger to resemble urine properly so called, in a
d, not to be urine.

5. Several chemists have thought to explain
particular nature of the urine by admitting
an attenuated oil, the ultimate products
e efforts of life, and of the motion of the
ns. Boerhaave has insisted the most upon
idea, which we find very fully and copiously
eloped in Haller's grand physiological
k. But it is evident that it was for want of
urate facts and positive experiments upon the
ure of the urine, that the medical chemists
osed this opinion, and that this pre-

tended oil was only a hypothetical principle, such as were very easily adopted at the period when this was admitted. Moreover when we enquire to what matter contained in the urine, this acrid oily principle, the ultimate product of the vital action, approaches the nearest, we find that the notion which chemists had conceived of it, at the commencement of the present century, corresponds, if not accurately, at least by sufficiently marked relations, with the most abundant urinary substance, which truly constitutes this kind of excremental liquid, and which I reserve for a particular consideration, on account of its importance, in the paragraph immediately following. We must not therefore admit oil properly so called, or the attenuated oily principle, in the urine; but consider it only as an improper synonym, as a bad and false denomination, given to one of the most important and most remarkable principles of this liquid.

77. No chemist has yet discovered or indicated silex in the urine; but as this earth has presented itself to us in the analysis of a calculus of the bladder, and as it must have proceeded from the urine in which the calculus had deposited itself, we have concluded that this liquid might in some cases contain the siliceous earth. Indeed, amongst several hundreds of calculi of the bladder, which of themselves are productions that fortunately are pretty rare in the urine, we found only one in which this earth formed a part of the nuclens. This

proves

proves that the presence of this earth in the human urine is an extremely rare circumstance; accordingly, I shall not yet rank it amongst the materials of this liquid. It is only by accident, in consequence of morbid circumstances but little frequent, as it appears, that silex forms part of this excrementitious humour. However, when we reflect that this earth is now found much more frequently in waters and in the vegetable matters than was believed to be possible, it is evidently natural to believe that it may exist in the aliments, and likewise that it may be evacuated with the urine. Possibly future researches, more accurate than those that have hitherto been made on this subject, may teach us, that this earth is to be met with more frequently than can yet be suspected, in the urinary excretion.

78. Lastly, the thirtieth and last principle that has been found in the urine, is that which is met with in it in the greatest abundance, the presence of which I have already repeatedly indicated, which has been mistaken by confounding it sometimes with an attenuated oil, sometimes with colouring matter, and sometimes with a kind of saponaceous extract: it is this substance which truly characterizes the urine, and is alone much more considerable than all the other materials of this liquid taken colectively, without which its urine would not be what it is; the more abundant quantity of which gives to this liquid its very marked

urinary characters, and the variable proportion of which produces the most striking differences in the several urines. As this matter performs a very important part not only with respect to the urine, but also with respect to the whole mass of the body, and as its distinction, its characters, and its properties, have hitherto almost entirely escaped the observation of chemists, I shall describe it particularly and carefully under the name of urée.

79. According to what I have indicated concerning each of the different materials which have been found or admitted in the urine, we may distribute them into four classes; the first comprehending those which are constantly found in this liquid; the second, those which are found in it only rarely, accidentally, and frequently in consequence of modifying causes; to the third I shall refer the matters formed by fermentation, and which are extracted only from the altered urine; and in the fourth, I shall place those which are only conjectural and hypothetical.

Eleven of the thirty principles indicated are constantly exhibited in the analysis of the urine, and truly constituent, so that they may be considered as excrements which must be discharged out of the human body by this way. Such are the urée, the gelatinous animal matter, the muriate of soda and of ammonia, the phosphates or soda and of ammonia, separate or united in triple salt, the phosphate of lime, the phosphate

hosphate of magnesia, the phosphoric acid, the ric acid, and the benzoic acid. Their respective proportions vary according to a multitude of circumstances; but natural and well constituted urine is always a solution of these eleven substances in a large quantity of water.

80. Many chemists have spoken of several other matters in the urine, and their assertions are too deserving of confidence, for us not to admit these matters, though the latest experiments show that they are rare and accidental in it. In this second class of materials of the urine we must place the muriate of pot-ash, indicated by Rouelle the younger; the sulphate of soda, admitted by the same chemist, as well as the sulphate of lime; the calcareous oxalate which must form part of it in the case of the production of a mural calculus; the saccharine substance, which exists in the diabetes mellitus, and perhaps in some othermorbid circumstances, silex and the albumen. We see that these matters may exist at the same time with the twelve preceding, that they are not contradictory to their presence, and that their attractions permit them to meet and remain in it with preservation of their nature, and without changing that of the constant and as it were essential materials of this liquid.

81. When the urine is fermented, besides the matters which it constantly emits, there are formed in it, at the expence of the urée, and the animal substance, the only alterable

and

and fermentable principles which it contains, acetous acid, ammonia, and carbonic acid; ſo that we then find in it, beſides theſe principles, the following additional ones, the benzoate, the urate, and the acetite of ammonia, ammoniaco-magneſian phoſphate, and carbonate of ammonia. The urée is no longer either ſo abundant or in its natural ſtate; its brown colour, and the dark coloured depoſitious which appear in it, prove that a portion of carbon is ſeparated: accordingly, when once fermented or altered by the ſpontaneous movement which is ſo early and ſo ſoon excited in it, the urine is no longer really the ſame liquid that it was in its natural and healthy ſtate.

82. As to the principles which I conſider as hypothetical, becauſe their exiſtence has never been proved, and becauſe their preſence has been admitted only according to mere ſuppoſitions, I find only five matters which are truly in this predicament; namely, the particular acid of Mr. Gaertner, the colouring matter, the odorous principle, the extract, and attenuated oil. I have proved in the preceding numbers, that theſe principles are in fact rather imagined than demonſtrated in the urine. It muſt be evident, that by this detailed conſideration upon each of the materials, I have aſcertained with preciſion the true conſtituent matters of the urine, and given a more exact notion concerning this liquid than had hitherto been preſented. It is alſo eaſy to perceive that I have had reaſon

ſon to preſent the urine, both as the animal liquid that has given occaſion to the greateſt number of diſcoveries, and as one of the matters which have furniſhed the moſt uſeful applications to the phyſics of animals.

SECTION VI.

Particular Examination of the Urinary Subſtance, or of the Urée.

83. I have already indicated a great number of times, in the preceding numbers of this article, the particular matter of which I am about to treat. It is this which gives the urine its colour, its ſmell, part of its taſte, and in general all the properties which characterize it as the urinary liquid. Without its preſence there would be no real urine; and when the liquid diſcharged from the bladder does not contain it in certain circumſtances, it has no longer the true characters of urine, but is in ſome reſpect a liquid foreign to its proper nature. The chemiſt, the phyſiologiſts and the phyſicians have never yet examined this matter under a ſimilar point of view; and yet it is worthy of all their attention, both with reſpect to the ſingular properties which diſtinguiſh it, and to the important relations which it preſents with the phenomena of the animal economy. Boerhaave,

Boerhaave, Margraff, Schloffer, and Pott, had, however, a notion of its exiftence. Rouelle, the younger, had defcribed fome of its properties, efpecially its cryftallization, its deliquefcence, its folubility in alcohol, its abundant converfion into ammonia, and he attempted to diftinguifh it by the name of faponaceous matter. Scheele badly defignated it by the name of extractive matter. Cruikfhanks, of late years, has better underftood fome of its particular properties, efpecially its cryftallization with the nitric acid, but he ftill calls it extractive animal matter.

84. In our long and laborious refearches upon the urine, Citezen Vauquelin, and myfelf, have paid a particular attention to this fubftance, becaufe we had found it to be the caufe and the fource of feveral very remarkable properties; it prefented itfelf to us in a multitude of circumftances and phenomena, which had not been fufficiently obferved by the chemifts; it has exhibited to us its peculiar nature, very different from that of any other urinary fubftance, as conftituting and characterizing the urine, fo that this liquid feemed to us not to be capable of exifting without it.

In our profound ftudy of it, we found the neceffity of giving it a name which might deftroy the ancient, imperfect, and even erroneous notions which had been given concerning it before us, and which might ferve to characterize it as a very diftinct animal matter, forming the urine by its folution in water. On this account

we

re have adopted the word urée which is sufficiently similar to that of urine, from which it differs only by its termination, in order always to call to mind its particular nature, and its intimate relation with the production of this liquid. Thus it will no longer be possible to confound it with an extract, a soap, or an oil, the properties of which differ in many respects from those of this particular matter.

85. It is necessary we should first relate the manner of obtaining the urée as pure as possible, for we have not yet been able to insulate it entirely from some of the other materials contained in the urine. I have already said that the urine, evaporated by a mild heat to the consistence of thick syrup, concreted, by cooling, into a solid, brown, granulated mass, which Boerhaave and Rouelle had compared to a sapa or kind of honey. This mass is a mixture of twelve different matters, since it is really an entire extract of the urine; but the urée forms the greater part of it, and its solubility in alcohol, whilst most of the other materials of this liquid are not soluble in it, has assisted us to obtain it almost pure. For this purpose we pour upon the brown granulated mass four times it weight of well rectified alcohol, at several times, in a vessel placed upon a mild fire; the liquor, whilst it dissolves almost the whole of it, assumes a dark brown colour, and leaves the greater part of the saline matters considerably pure: Rouelle had recommended a similar means

means for purifying the salts of the urine. The alcoholic solution, placed in a retort of glass, must be distilled on the sand-bath; there passes over a fetid alcohol, charged with carbonate of ammonia, and effervescing with the acids, which give it a rose colour. When the liquor is of the consistence of a thick syrup, it hardly contains any more alcohol; as it cools it crystallizes into laminæ crossing each other, seemingly quadrangular, cut off or imperfect at their sides, of a brilliant yellowish white colour, and brown in some of their surfaces. This is the urée mixed with a small quantity of muriate of ammonia, as well as with benzoic acid, of which it is impossible entirely to deprive it; but it is sufficiently pure to present the properties which characterize it.

86. The whole of the urée prepared in this manner is crystallized; but it has hitherto been impossible for us to determine, with exactness, the form of its micaceous brilliant laminæ, always grouped together, and pressed against each other, and always incomplete. Though hitherto incapable of an exact description, this form, however, presents an appearance which sufficiently distinguishes it from any other animal substance, of whatever nature it may be, for it to be impossible to confound it, or not to distinguish it with ease. It exhales a strong, fetid, and alliaceous smell, which is repulsive to animals, and seems to affect the nerves and the brain in a dangerous manner

ner when expofed to it for fome time. It adheres to the veffel which contains it; it is rather difficult to cut or break it; it is hard, granulated, very confiftent at its centre; it becomes foft and like thick honey at its furface; it ftrongly abforbs the moifture of the atmofphere, and the portion diffolved by this deliquefcence runs in a thick liquid round the whole mafs, which it detaches in part from the fides of the veffel, and which it turns brown in all the points at which it infinuates itfelf. Its acrid, pungent, and very difagreeable tafte, refembles that of the ammoniacal falts.

87. The urée introduced with caution into a retort, with a wide and fhort beak, to which a receiver and the pneumato-chemical apparatus is adapted, comports itfelf by the fire, and in diftillation, in a manner peculiar to itfelf. It is quickly fufed; at firft there is raifed a white fume, which condenfes upon the fides of the retort in laminæ, which are eafily diftinguifhed to be benzoic acid. Soon the firft fublimate is fucceeded by cryftallized carbonate, the production of which continues, without interruption, to the end of the operation. Neither aqueous liquor, nor oil is obtained, but the fublimed product is turned brown. The air of the apparatus impelled into inverted glaffes, placed at the extremity, is impregnated with a fetid alliaceous odour, refembling that of putrefied fifh. It carries off in folution carbonate of ammonia, which is difcovered by the precipitate

which

which it occasions in the well-water which is frequently employed for filling the pneumato-chemical vessel. Its infectious odour becomes horrible, and insupportable, when the heat is very intense. The matter in the retort is then dry, blackish, and covered with a raised white crust, which elevates itself at last in a heavy vapour, and attaches itself to the lowest part of the vault, and of the retort; this is ammoniacal muriate. We observe nothing more in this operation, carried on for two hours, and till the retort is perfectly red-hot, and ready to melt. The coaly residue, when water is poured upon it, exhales a smell of Prussic acid; burned by an open fire, it exhales also ammonia, and a Prussic smell of bitter almonds; it leaves one hundredth of the weight of the primitive matter of an acrid white cinder, which turns the syrup of violets green, and contains a small quantity of carbonate of soda.

88. Though several times repeated, and with all possible attention, however disagreeable it might be, this distillation could afford us only some general notions respecting the nature of the urée; it exhibited to us in it benzoic acid, muriate of ammonia, and a small quantity of muriate of soda accompanying this matter; it ascertained to us that it was itself very decomposable by the fire, affording ammonia as the most abundant of its products, but neither water nor oil, forming also, carbonic acid, and Prussic acid, affording neither hidrogen gas, nor car-

bonic

bonic acid gas, nor azotic gas, at leaſt not in ſufficient quantity to be obtained inſulated. We were obliged to conclude from this kind of analyſis, that the conſtituent principles of the urée, when ſeparated by the fire, unite, almoſt all, two and two together, the carbon with the oxigen, the azote with the hidrogen; that they united all together only in a ſmaller portion, in the proportions proper for forming a ſmall quantity of Pruſſic acid; that the large quantity of ammonia, which greatly exceeds the other products of this decompoſition, announced that the proportion of azote was greater than that of all the other principles of this matter; and laſtly, that the formation of carbonic acid, in ſufficient abundance to ſaturate the ammonia, proved the preſence of oxigen in it, ſo that the urine appeared to be a quaternary compound of azote, hidrogen, carbon, and oxigen, in which the firſt of theſe principles predominated.

89. The urée is extremely ſoluble in water, as is proved by its deliqueſcence. When we pour a little water upon it, it abſorbs it pretty quickly, and is ſoon diluted with it, producing a ſenſible refrigeration, and aſſuming a brown colour and a thick ſtate. When we throw cryſtalline maſſes of urée into this liquid, it melts in it, preſenting thick brown ſtreaks. When the ſolution is ſufficiently liquid and clear, which is effected with four or five parts of water to one of urée, it exhales, when agitated in the air, ſome white fumes, which appear

appear to depend upon the difengagement of ammonia, that becomes fenfible by the odour developed at the fame time. This liquor, when left to itfelf in a well-clofed veffel, keeps for a long time without alteration; when an animal matter is added to it, whether albumen or gelatin, it ferments at the end of fome days, and is converted into acetous acid and ammonia. It is to its great proportion and its purity that the inalterability of fome of the highly coloured urines is to be afcribed; whereas thofe which contain at the fame time a gelatinous fubftance, which performs the function of a ferment, become altered more or lefs eafily and quickly.

90. The aqueous folution of urée, treated by fire, prefented to us a phenomenon much more important and inftructive than the diftillation of the dry urée alone. Diftilled by a mild fire, carried to ebullition, it afforded very clear water charged with ammonia; when the liquor was infpiffated to the confiftence of a fyrup, four parts of water were added to it, and the fame product was obtained, flightly coloured; three other fucceffive additions of water furnifhed alfo liquid carbonate of ammonia, only more and more coloured, and from which a fmall quantity of carbon was precipitated. We thus obtained nearly two-thirds of the weight of the urée in carbonate of ammonia, and the portion which remained in the laft refiduum was ftill urée not decompofed and fufceptible of being converted into this falt. Thus the mere

temperature of ebullition, which does not ſenſibly alter the animal ſubſtances (properly ſo called) in their intimate compoſition, eaſily decompoſes the urée which preſents an equilibrium much leſs permanent in its nature, and a converſion into carbonate of ammonia, infinitely more eaſy, becauſe it is more abundant and more prompt than in any other animal ſubſtance, whatever it may be. So that there is this very remarkable difference between the ordinary animal compound, and this eſſentially urinary compound, that the firſt undergo coction, and become more fit for digeſtion by this boiling temperature of the water, whilſt the urée is decompoſed and converted into ammonia and carbonic acid by this degree of heat. This eaſy and very remarkable decompoſition is more eſpecially peculiar to this product of animalization with relation to the formation of the carbonic acid, which, in the other matters in which it is obſerved, generally requires a temperature much ſuperior to that of boiling water. Every thing, therefore, concurs to prove, that the urée is more decompoſable, and much leſs durable or permanent in its compoſition, than any other animal matter hitherto known; and that it requires only a ſlight change of equilibrium to cauſe it to paſs into the ſtate of ammonia, and of carbonic, Pruſſic, and acetous acids.

91. Amongſt the alterations which the acids produce upon the urée we muſt eſpecially diſ-

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tinguish that which the nitric acid presents, since the action of the others has nothing comparable to it, or that particularly merits our attention. Indeed, the concentrated sulphuric acid burns it; but the muriatic, the phosphoric, the fluoric, and the carbonic, produce no alteration upon it. The oxigenated muriatic acid decomposes it, separates it in part from the water in which it is dissolved in the form of yellow flakes, precipitates carbon from it, discharges from it carbonic acid and azotic gas; it also reduces a small portion of it to the oily state, and decomposes the ammonia which it forms at first, which is perceived by the long effervescence and the very small but continual bubbles which are disengaged from the liquor during a very long time. The product of this effervescence is azotic gas.

The nitric acid acts upon the urée in three different manners, according to the process which is followed for this action. If we throw highly concentrated nitric acid upon this matter in its solid and crystallized state, a very considerable movement of ebullition is excited; the urée swells much, exhales a very thick vapour into the air, without inflaming, and is found afterwards both in the state of solid and yellowish crystals, and in that of a very brilliant red liquor: the action is so violent that it is not possible to collect the gas.

When we pour weaker, but however sufficiently strong nitric acid, upon a thick so-

lution of urée in water, we immediately fee radiated and lamellated cryftals, formed of a yellowifh white colour, fmooth and unctuous to the touch, in great abundance, which almoft fill the veffel, and appear to be a combination of the matter little or not at all changed by the nitric acid. The fame refult is obtained with urine ftrongly evaporated, and treated with nitric acid a little concentrated. This fingular effect, which was before remarked by Mr. Cruickfhanks, is fo peculiar to the urine, that it characterizes it, and in effect diftinguifhes it from all other poffible matters; it deferves ftill more to be defcribed and examined with much attention.

Laftly, if we diftil nitric acid upon the urée diffolved in water, we obtain by an effervefcence which continues for feveral fucceffive days, an enormous quantity of carbonic acid gas, and azotic gas; Pruffic acid gas is alfo difengaged: the products received into water render it acrid and very pungent. When the matter contained in the retort begins to thicken, it inflames with a violent explofion, and there remains only a light fat refiduum, the lixivium of which made with water precipitates the fulphate of iron in the blue ftate. In this operation the urée is decompofed; it affords much azotic gas and ammonia, which produces, with the nitric acid, the detonation that has been indicated; there is alfo formed much carbonic acid gas, and a little Pruffic acid. A portion

of its carbon is precipitated; the liquid product has a yellowiſh colour, and is covered with a little oil.

92. The cauſtic alkalies, whilſt they diſſolve and ſoften the cryſtallized urée, diſengage ammonia from it, and at firſt decompoſe that portion of ammoniacal muriate, which is contained in it. If we heat a ſolution of this matter with a ley of pure fixed alkali, much ammonia is volatilized, and the pot-aſh is afterwards in quadruple combination with the benzoic and muriatic acids naturally contained in the urine, and with the acetous and carbonic acids, which are formed in it during the action of the alkali and of the caloric upon this matter. If we afterwards diſtil the urée mixed with alkali which has already re-acted upon it, with the ſulphuric acid, we obtain water charged with acetous acid, and a ſmall quantity of benzoic acid. Thus the urée comports itſelf with the alkalis, as in the ſlow and ſpontaneous decompoſition, or by the action of a mild fire; we always ſee it converted into ammonia, carbonic acid, and acetous acid; its conſtituent principles relinquiſh their quaternary combination to form ſeveral binary ones, and one of theſe three materials, but always in the ſame order as has hitherto been obſerved.

Barites and ſtrontian produce preciſely the ſame effect as pot-aſh and ſoda. Ammonia exerts no ſenſible action upon the urée. Lime diſengages from it the ammonia of its muriate

by ſimple trituration; if it be very quick, it firſt abſorbs its humidity, with which it becomes heated; afterwards it dries it, and in part effects its decompoſition: ſo ſtrong is the diſpoſition of the urée to paſs almoſt entirely into the ſtate of carbonate of ammonia.

93. One of the moſt remarkable, of the moſt ſingular, and at the ſame time, the moſt characteriſtic properties of the urée, conſiſts in the influence which it has upon the cryſtallization of two ſalts contained in the urine. This influence, which chance firſt preſented to Citizen Vauquelin and myſelf, and which it would have been impoſſible for us to have diſcovered without the extenſive reſearches which we had undertaken, upon the urine and its products, is a phenomenon which may hereafter contribute to throw ſome light upon the knowledge of cryſtallography. Having very attentively examined ſome regular octahedral cryſtals formed in the leys of ſalt of urine, ſet to purify, we found that they were compoſed of real muriate of ſoda, intimately mixed with a brown colouring matter; on the contrary, cubic cryſtals, formed in like circumſtances, and proceeding from urinary ſalts, preſented to us all the properties of the muriate of ammonia. This kind of reciprocal inverſion of the form of the two ſalts, the firſt of which is naturally cubic, and the ſecond octahedral, having attracted our attention, and excited our ſurpriſe, we thought it incumbent upon us to inveſtigate its cauſe.

causes and the circumstances of the variations of form with which saline matters are so frequently affected both in nature and art.

95. Urée unites with many vegetable matters which, like it, are soluble in water; it appears, on account of its great solubility, to be capable of separating from this liquid some of the immediate materials of the vegetables which have less attraction for it than it has itself; such as the insipid mucous and the saccharine substance. For the rest we have as yet very imperfect notions respecting their reciprocal action; we are also ignorant of its manner of acting upon the oils, though it is probable that it renders them miscible with water, and that it is on this account that urine is useful in fulling.

Alcohol easily dissolves the urée, less abundantly, however and less speedily than water does. It dissolves it much more easily with the aid of heat; and as the urée is precipitated from it by refrigeration in the crystalline form, this is the means of obtaining it in the regular form, which we have successfully practised, as I have already said (No. 85). When the alcoholic solution of urée is boiled for some time, this matter is slowly decomposed, a great part of it passes into the state of carbonate of ammonia, which is disengaged and rises in vapour with the alcohol, as it is volatilized. We here see an effect analogous to that of boiling water, and a similar tendency on the part of the urine, to

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pass into the ftate of its accuftomed or as it were habitual decompofition.

We know nothing refpecting the combinations of urée with other animal fubftances; it has not yet been poffible for us to appreciate the attractions and the relations which exift between it and thofe fubftances: undoubtedly there remain fome ufeful difcoveries to be made upon this fubject.

96. In the ftate in which our refearches yet are with refpect to this urinary compound, though little advanced with refpect to what this new career promifes to ulterior refearches, they are neverthelefs fufficient to prove what I have already advanced, that this fubftance differs from all other matters; that it is of a very peculiar kind; that it is a compound in which azote predominates, which prefents itfelf as the ultimate term of animalization, and may be confidered as an excrement of which nature muft difcharge itfelf, and life muft repel far from its focus. The diftinct and characteriftic properties that lead to this conclufion, are its ftrong fmell and tafte; its difpofition to cryftallize; its very eafy decompofition by a great number of agents, and always in the fame manner; its converfion into the ftate of ammonia, of carbonic acid, of acetous and of Pruffic acid; its extreme tendency to the putrid alteration, which it undergoes efpecially when it is mixed with afmall quantity of animal fubftance extraneous to its proper nature; and even

even the remarkable influence which it exerciſes upon the otherwiſe conſtant and even tenacious form of two ſalts, which are not known to vary except with the utmoſt difficulty.

SECTION VII.

Of the Varieties of the Human Urine.

97. I HAVE hitherto treated only of the urine of the healthy adult, in its moſt natural, and moſt common ſtate; but this liquor is not always conſtant and identical. By conſidering all the variations of which the urine is ſuſceptible; and are of importance to animal phyſics and medicine to be known, I find ſix principal ſources of the varieties which affect it, or ſix kinds of cauſes which render it different, all of which merit an equal attention on the part of the phyſiologiſt. In fact, urines vary, 1. According to the age of the individual. 2. According to the time of the day; 3. At different ſeaſons; 4. According to the aliments; 5. According to the paſſions; 6. In diſeaſes. Each of theſe cauſes influences the nature of the urine in a very peculiar manner. Medicine has indicated a great number of theſe varieties but only according to the ſenſible appearances or the external characters. It is for chemical

analyfis to determine the real nature of thefe differences; but unfortunately it has hitherto done fcarce any thing with refpect to this important part of phyfiology. Accordingly, what I fhall have to fay refpecting this fubject, will be only a feeble outline of what the art will hereafter poffefs, a feries of views which this kind of refearch prefents, rather than an accurate detail of what it has actually afcertained.

98. The age of the individual has a very decided influence upon the nature of the urine. It has already been remarked that the liquid which the bladder of the fœtus in utero contains, is without colour, without fmell, and almoft mucous. That of infants, in the firft years of life, contains no earthy phofphates, and is found to be charged with benzoic acid; it is alfo little coloured, little odorous, and affords only a fmall portion of urée. It feems that this excrement is only the product of the vital action arrived at all its force, and of a too great redundancy of animalized matter, which does not exift in young fubjects. The phofphate of lime is alfo not found in it, fince there is no fuperabundance of this in the humours as long as the work of offification is not completed, as long as the bones have not yet attained their full growth and perfect folidity. The adult in whom thofe functions are fixed, and who admits a more abundant fuperfluity of his nourifhment, emits a ftrong urine, charged with falts, with earthy phofphates, with phofphoric acid, with urée

urée and with uric acid, ſuch as has been conſidered in the preſent article. In the urine of perſons advanced in years, there is frequently conjoined with the urée a nutritive mucilage and a great quantity of uric acid and of calcareous phoſphate, with which the oſſeous ſyſtem is ſurcharged: accordingly, they are the moſt ſubject to calculi. A comparative analyſis of the urine, of the different periods of life, is however ſtill wanting.

99. The time of the day, more or leſs diſtant from that of the meals, has alſo a great influence upon the urine of man. I have formerly diſtinguiſhed, with the moſt enlightened phyſiologiſts, eſpecially Haller, the urine of drink, the urine of the chyle, and that of digeſtion, or of coction. The firſt, which is voided a ſhort time after a meal, is limpid, colourleſs, and ſeems to be ſcarcely any thing more than water; its abundance, and the ſhort time after drinking that it is diſcharged, have led ſome to think that it is the water received into the ſtomach which paſſes immediately into the bladder: this is not urine ſtrictly ſpeaking, when it has not the lemon yellow colour. The light yellow colour which it ſometimes has, authorizes us to conſider it as urine very much diluted, in which the urée is extended with a large quantity of water. Such is generally that which is voided three or four hours after a meal, and which with this character combines that of being frequently charged with the

ſmell of the aliments. The urine is not well conſtituted or completely formed, till ſeven or eight hours after the meal, and when the diſtribution of the chyle in the blood is entirely effected, it is then coloured, odorous, aromatic, ſaline, and charged with urée, like that which has been deſcribed in the preceding paragraph.

100. We are as yet far from being acquainted with the influence of the paſſions upon the variations of the urine: It is only very evident that it is of two kinds; the one, which relates to this liquid itſelf, ſuch as it is diſcharged out of the bladder; and the other which is exerted according to the external temperature upon the urine when once diſcharged out of its receptacles. In general, it is commonly known that the urine in warm weather and in hot climates is highly coloured, very acrid, and produces a burning ſenſation in the canals through which it paſſes. This ſtate, which contains more ſalt, more urée, and conſequently leſs water, is generally attributed to the great evaporation of this liquid, produced by the high temperature of the atmoſphere, and to the abundant tranſpiration which is ſuppoſed to exiſt in theſe circumſtances. In my opinion, it proceeds ſtill much more from the tendency which the humours and the whole animal economy then have to paſs into putrefaction, to the exceſs of animalization which accompanies the high temperature of the atmoſphere, and to a greater combuſtion

voided ſuch red urine that he thought it was blood; but as he experienced no pain nor inconvenience, and had not the ſlighteſt ſymptom of any diſeaſe of the urinary organs, Roux on enquiring carefully into the nature of the food and drink which he uſed, learned that this perſon had eaten a great quantity of red beet for ſome days paſt: and in fact, the mere abſtaining from that aliment cauſed his urine to return to its natural ſtate.

The ſmell which aſparagus communicates to urine, muſt certainly be reckoned amongſt the moſt extraordinary changes produced upon this liquor by the aliments. Its fetidity is well known; but we are yet ignorant in what this change conſiſts, whether it be a matter added to the urine, and what is its nature, or whether it be only a modification of the urée, or of the other materials of this liquor. The oppoſite influence which turpentine, the balſams, the reſins, and the volatile oils in general exert upon the urine, the ſmell of which they change into a perfume like that of violets, and with a rapidity of action which always aſtoniſhes the obſerver, is no leſs worthy of remark. The ſtate of animal phyſics requires at preſent that we ſhould not be ſatisfied with concluding that theſe ſubſtances are diuretic, but that we ſhould inveſtigate, as well with reſpect to the other kinds of modifications produced in the urine by the aliments and medicines, to what thoſe ſingular changes are

to

to be afcribed. It muft be by accurate chemical refearches that the caufe of thefe phenomena will be difcovered.

103. Even the paffions are found to influence the nature of the urine: fright, vexation, grief, and in general, the affections of the mind which agitate the machine, efpecially fudden fhocks, frequently caufe an abundant difcharge of urine, exceeding in quantity the aliments that have been taken, and voided at the very moment of thofe affections. This urine is limpid, crude, without fmell or tafte, and almoft entirely confifting of water. This is an effect known to mothers, who, when their infants have experienced a fright from any caufe, efpecially by a fall or a blow, never fail to invite them to make water, knowing well that they are much difpofed to do it. It is known that the inclination to drink frefh water is perceived at the fame inftant, and that it feems as if nature thus impels us to fupply the lofs of water which the fright has occafioned. This phenomenon takes place even in the domeftic animals, which, partaking of our focial enjoyments, participate at the fame time in our paffions and our evils. It is alfo remarked to be much more frequent and perfceptible in their youth than in their adult age. The functions of the kidneys and bladder are as yet too little known to enable us to afcertain upon what this effect immediately depends.

104. But

104. But the six kinds or varieties of the urine which have just been examined according to the influence of the périods of life, the times of the day, the seasons of the year, the aliments and the passions, are effaced in some measure, and are only slight modifications when compared with those that are the consequences of morbid changes. Here the scenes are much more numerous, the alteration of nature more profound, the varieties of properties more multiplied and more characteristic. Hence it is that physicians after having from the early times of antiquity, acknowledged the importance of this observation, have sought, in the urine of their patients, means of ascertaining the nature of their affections, their progress, and even prognostics of the events that are to be expected : and though on the one hand uroscopic empyricism has almost in all ages laid human credulity under contribution, and though on the other, notwithstanding the multiplied observations of the most able practitioners, the art is very far from having attained to that eminence of which it may be hoped that it may hereafter arrive; its annals already contain a certain number of valuable facts, which when approximated with chemical knowledge, may throw some light upon pathology.

105. When we compare all the facts hitherto observed with the greatest accuracy respecting the morbid urines, and carefully exclude all the general and vague assertions which fill so many works on Symptomatology and Pathology, we find

find eight kinds of urine sufficiently well determined by their marked characters, respecting the knowledge of which the present state of chemistry, and the analysis of this liquid, such as I have presented it, may afford some precise notions, I shall here designate them by their medical names, as they constantly accompany determined diseases or pathological circumstances: those are the inflammatory, the billious, the critical, the nervous, the arthritic, the calculous, the rachitic, and the diabetic urines. I shall subjoin to the examination of each of these determinate kinds of urine, the enunciation of some other more general pathological modifications which this excrementitious liquor presents, and which, without belonging each to a particular disease, present preternatural properties or alterations, which are met with in several affections, different from each other; so that they are eventual indications or signs, but not constant and pathognomic symptoms: such are the colourless, the red, the green, the turbid, the sedimentous, the glairy, the oily, the sanguineous, the purulent, and the ammoniacal urines.

106. At the commencement of fevers and inflammatory diseases, the patient generally voids a burning, high-coloured red urine, nearly resembling the blood in colour, hot and acrid, and which strongly irritates the canal of the urethra. This kind of urine, called inflammatory has been more especially observed after the

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attacks of intermittent fevers. This ſpecies of urine does not ſoon depoſit; it does not become turbid by cooling; gives no ſediment, and is conſtantly met with in all caſes, in which the temperature of the patient's body is elevated; the ſenſation of heat energetic; the contraction of the heart, and of the arteries more ſtrong, and the motion of the blood more rapid, than in the natural ſtate. Phyſicians are well acquainted with this kind of urine; it ſerves them as a uſeful indication, eſpecially when aſſociated with other ſymptoms, for aſcertaining the ſtate and the violence of inflammatory affections. When it continues for a long time in theſe diſeaſes, it is reckoned among the unfavourable circumſtances. It has not yet been examined chemically; it may be ſuſpected that the urée is very abundant in it, and ſtill nearer to decompoſition, than in the ſtate of health: it is of great importance to confirm this notion by experience; and on this account I would propoſe a clinical eſtabliſhment to be added to thoſe which exiſt; a laboratory, in which the urine of perſons labouring under different diſeaſes, ſhould be examined. That of inflammatory diſeaſes, ought to be one of the firſt ſubjected to this examination.

107. All the bilious affections, both febrile and chronic, are accompanied, and ſometimes preceded by a very remarkable urine, well known and diſtinguiſhed by phyſicians, which they call bilious, and which is characterized

by an orange-yellow colour, resembling the tincture of saffron: imparting the same tinge to the bodies, that are immersed in it. and to the bottom of the vessel in which it is contained. I imagined, nearly twenty years ago, that I had found the bilious colouring matter, in this species of urine; because having dissolved its extract in alcohol, I had seen this solution precipitated by the addition of water. This fact appeared to me to accord likewise with the notions generally prevalent amongst all medical practitioners, who do not doubt that the colour, and even the matter of the bile may pass by the urine. But other experiments that have since been made, and in cases where in strongly bilious urine, acknowledged as such by able, skilful, medical observers, presented neither the bitterness which characterizes the billiary matter, or its chemical properties, especially the precipitation of its solution in alcohol, by water, which distinguish it, have not confirmed my first result, and have forced me to remain in doubt, respecting the pretended immediate passage of the colouring substance of the bile. The bile has appeared to me, though well distinguishable by physicians, no longer to present its distinctive characters, but consequently to have undergone some alteration, the nature and cause of which cannot be appreciated without subsequent chemical results, obtained by more complete experiments, and a greater number of means, than I have been able to employ.

These researches, as well as several others, of which I shall hereafter speak, enter into the plan of the chemico-clinical experiments above-mentioned. (No. 106.)

108. The most ancient and most constant observations have proved, that at the termination of acute and febrile diseases, at the moment when the amelioration of all the symptoms induces a favourable turn; when the evacuations called critical, accompany this amelioration, the urine is voided more abundantly, and more easily, highly coloured, without being ardent or inflammatory, and deposits as it cools, a pulverulent, crystalline, or slightly scaly matter, of a pale red colour, which easily collects and is precipitated to the bottom of the vessel, without remaining long in suspension; this is what is called the critical urine. Scheele says, that the matter of this deposition is uric acid, and that the proportion of this acid is singularly augmented by the action of diseases. In fact, we find in it a large quantity of this acid, but it is not pure: it is mixed with a mucous animal matter, which frequently constitutes a great part of it, and earthy phosphate. This is one of the analysis of the urine, which most deserve to be repeated and varied by differen means in the chemico-clinical institutio which I propose: since, besides the augment proportion of uric acid, the cause of which, i of so great importance to endeavour to determi we must likewise distinguish the animal ma

sation of the attack. He believed, according to this observation, that the pain of the gout was occasioned by the regurgitation of the acid phosphate of lime, which irritated the membranes and the articulations: however, the nature of the arthritic concretions does not correspond with this notion, because they are not found of the same substance. For the rest, the absence of acidity, and of the phosphate of lime, which cannot be doubted in the gouty urine, may be a necessary state, simply concomitant of the arthritic affection, without being the cause of it; perhaps there may be a still more immediate relation between the deposition of urinary calculi, and the attacks of the gout, since long experience proves that the formation of calculous concretions frequently succeed arthritic pains; new researches therefore remain to be made respecting those relations, and their mutual influences: they require the precision and accuracy with which these investigations are at present generally conducted.

111. The urine voided by rachitic patients, at the time when their bones become softened and deformed, is frequently charged with phosphate of lime, and deposits a large quantity of it by cooling. It is easily perceived by an attentive observation of the principal circumstances of this disease, that a great operation goes on in the whole osseous organ; that this system undergoes a real decomposition; that its calcareous phosphoric part is dissolved; that

that its gelatinous part becomes insulated and inflated; that the solution of the phosphate of lime is effected by an acid, and that it is carried abundantly into the urine. An examination of this liquid, in well marked cases of rachitic, may throw great light upon the phenomena of this terrible affection, which attaches itself to the first ages of man, and leaves during his whole life, traces of its ravages, and frequently even dangerous remains of its virulence. Citizen Bonhomme, of Avignon, in a very good memoir which obtained one of the prizes of the ancient society of medicine, upon the rickets, asserts, that the softening of the bones in this disease, depends upon the presence and the action of the oxalic acid, generated in the bodies of infants, by the debility of their organs, the weakness of their stomach, the feebleness of their digestion. If this notion, which the author has not yet well proved, be just, its confirmation will be found in the nature of the urinary deposition, which must be oxalate of lime; and this might explain how the calculus of the same nature, of which we shall speak in the following article, is formed in the urinary passages. Citizen Turquais, a medical student in the school of Paris, has already communicated to me, an observation respecting the urine of an infant that died of a disease originating from worms, which became turbid almost immediately after it had been evacuated, and the sediment of which, exhibited to him

in its analyfis, all the characters of oxalate of lime: it is evident, to how many valuable refearches the examination of the urine of rachitic patients may give occafion.

112. There are two forts of diabetes, or of immoderate evacuation of urine; with relation to the nature of this liquid: in the one, which appears to be the moft frequent, the urine is colourlefs, white, infipid like water, and feems to have all its characters; this difeafe is generally accompanied with a great thirft, with rigours, and with a general coldnefs of the body. The other fpecies confifts in the difcharge of an abundant urine, of a faccharine tafte; on which account it is called the *diabetes mellitus*, or the faccharine diabetes: this, which is much more rare than the former, has been feveral times obferved in England, and defcribed with much attention, both with refpect to the diagnefis and the fymptoms, in its caufe and its treatment, by Dr. Rollo, an Englifh phyfician. By evaporating the urine of the latter, an extract is feparated from it, which is fweet, like honey, and prefents many of its properties. Cullen had before obferved it in the hofpital of Edinburgh, and he obtained this faccharine matter by evaporation. There is reafon to believe, that in this cafe, this matter fupplies the place of the urée that is wanting, and that then the liquid of the kidneys has not really the properties of urine. It is to an alteration in the digeftion, that Dr. Rollo afcribes the

production of this singular disease; accordin[g] to him, there is formed in the stomach, a rea[l] mucoso-saccharine substance, which, on ac[-]count of its abundance, passes off by the urinar[y] passages. I have already observed, in the arti[-]cle concerning the milk, that with females tha[t] give suck, the matter which is called the suga[r] of milk, is formed by digestion, and that th[e] nurses are in a state, analogous to that of per[-]sons labouring under the saccharine diabetes[;] it is possible that a saccharine character may b[e] found in their urine, especially under some cir[-]cumstances, when the milk is determined les[s] towards the breasts. This is another subject of the most important and most useful researche[s] for the progress of the art; and it is to those who are much conversant with women tha[t] give suck, that it ought to be presented an[d] recommended.

113. Diagnostic and prognostic symptoms have frequently been derived from the colou[r] of the urine in diseases; and though strang[e] abuses have been committed, respecting th[e] variations of this character, which, alone, an[d] without other indications, generally present only a source of illusions, errors, and uncer[-]tainties; it is, nevertheless, accompanied wit[h] some circumstances, the relations of which with the state of the animal economy, are es[-]sential to be known. In general, a natura[l] state of the urine in an otherwise severe disease is an alarming symptom. We have alread[y]

seen

ſeen in what caſes the urine is white and colourleſs, as well as what this indicated; I have likewiſe ſpoken of the red, ardent, inflammatory urine. Green or blueiſh urine has ſometimes been obſerved with or without ſediment. Sometimes, though ſtill more rarely, this liquid is of ſo dark a colour, that it appears to be black. In theſe caſes, the defect is generally aſcribed to the thickened bile, and even the atrabile or melancholic humour, conveyed to the different reſervoirs. As we have no accurate notion concerning the atrabile, it is evident that nothing can be ſaid reſpecting the green, black, and atrabilious urines, without having examined them chemically. It is however well known in practice, that theſe kinds of urine are very unfavourable, and that they indicate the greateſt danger, in the caſes in which they are obſerved. It is evident, how much light a well made analyſis of this liquid, thus altered, muſt diffuſe over pathology.

114. I have already ſpoken of turbid urine, which muſt be well diſtinguiſhed from the ſedimentous. The firſt is evacuated with a precipitate already formed, and frequently announces a degeneration, or alteration, which depends upon diſeaſes of the urinary paſſages or organs: the ſedimentous, which do not depoſit till after they have been evacuated, and are not properly critical urines, in which a light homogenous precipitate, of a roſe or lilac colour, is formed, and held for a long time ſuſpended

fuſpended, are oftener met with in the chro
diſeaſes; their depoſition is compoſed of ea
phoſphates, and depends chiefly upon the
eaſes of the bones, of the articulations, o
membranes, and of the muſcular and ſenſibl
gans. Thoſe kinds of urine merit all the at
tion of phyſicians, and ought, in what
diſeaſe they preſent themſelves, to be ſubje
to an accurate analyſis.

There is known in medicine, a glairy, t
urine, ropy throughout its whole maſs, or
in ſome parts of it; ſometimes more or leſs t
flakes are ſeparated from the urine and
poſited, and adhere more or leſs ſtrongl
the ſides of the veſſel. Both theſe u
generally accompany the diſeaſes of the l
der, and it is thought that the kind of m
which ſeparates from them, proceeds
the membranous and ſenſible ſides of this
cus.

As to the oily urine, which is extremely
and perhaps never actually exiſts, it is conſi
as the ſtrongeſt proof of an inveterate acrim
or advanced decompoſition of the hum
There is reaſon to believe, that the urine w
has been deſignated by this name, on acc
of a ſlight ſtratum of a greaſy appearanc
not really oily; but that the ſuperficial l
which has been taken for oil, is only the
duct of a ſaline evaporation, as we ſee in n
chemical ſolutions, the ſurface of which
ſ

ſents, by the contact of the air, a ſmall portion of their ſalt ſeparated from the liquor.

115. The urine is ſometimes ſanguinolent, or mixed with a more or leſs abundant quantity of blood; frequently this liquid is ſeparated and depoſited at the bottom of the urine, in the form of blackiſh brown flakes, which are gradually diſcoloured and diſſolved, becoming reduced into white flakes, ſimilar to a thick glairy matter. Great care muſt be taken not to confound the ſanguinolent urine, either with that which is coloured by the abundance and acrimony of the urée or of the uric acid, or with that which has taken a colouring matter from any aliment, or medicine, ſuch as beet-root, or madder. The urine charged with blood, proceeds in general from an affection of the kidneys, of the ureters, or of the bladder, which almoſt always depends upon a laceration of the veſſels, produced by the preſence of a tuberculous or ſpinous calculus. Sometimes, however, the blood in the urine proceeds from a deviation of another ſanguinous evacuation, ſuch as the menſtrual or the hemorrhoidal diſcharge. The latter is diſtinguiſhed by its being voided without previous pain, and with the ſigns of the ſuppreſſion of the menſes, or hemorrhoidal flux, whereas the ſanguinolent urine proceeding from a defect of the urinary organs, is preceded by acute pains, and not by ſuppreſſion of other evacuations.

The

The purulent urine, from which the pus th is voided with it separates and is precipitat in a thick liquid, of a white or greyish colou proceeds also from a disease of the urinary o gans, and an alteration in some of their region sometimes, this liquid is so much altered b long continued diseases of the bladder, and th time which it remains in it, as to be voided i a fetid and ammoniacal state. This is one of th characters which the urine of calculous patient easily contracts, especially with old person labouring under these affections. It is suffici ently distinguishable by its strong smell; instea of being acid like healthy urine, it turns th blue vegetable colours green.

SECTIO

Section VIII.

Of the Varieties of the Urine in the different Animals.

116. THOUGH the urine has hitherto been epresented as a liquid of a particular nature, nd characterized by properties which exclu- vely belong to it; though we may even re- refent to ourselves, according to these notions, e urine of the different animals as approach- ng in a remarkable manner to the nature of at of man, especially by the presence of the rée which gives it its specific characters of n excrementitious humour, and, as it were, an ltra-animalised matter; there must, however, xist in this liquid, considered in the different lasses of animals, differences inherent even in heir nature and the diversity of their organs, f their nourishment, of the medium in which hey live, of their mode of respiration; all which ircumstances, as I have shown, influence ts properties. And in fact, notwithstanding he small number of researches that hitherto xist in this respect in the annals of the science, wo constant results have already presented hemselves to chemists in the first labours f this kind which they have undertaken: the ne, that the urine of every terrestrial quadru- ped,

ped, or mammiferous animal contains the ſpecific urinary principle or the urée, which gives it its true nature; the other, that it is in the number, the proportion, and the different ſpecies of the ſaline ſubſtances which are diſſolved in it at the ſame time, that the differences which this liquid exhibits alone conſiſt. Indeed we have hitherto examined only the urines of the horſe, of the cow, and of the camel, the analyſis of which has been deſcribed in 1773, and 1777 by Rouelle, the younger. But beſides that of the horſe, which Citizen Vauquelin and myſelf have repeated, and in which, together with the principal characters of that of man, we have found ſomething more than this able chemiſt had done; beſides the ſtriking analogies, which theſe three kinds of urine, already well known, preſent with each other, and with that of man: ſome facts which we have hitherto been able to collect upon the urine of the hare, of the guinea-pig, of the cat, and of the tortoiſe, aſſure us ſtill more of this analogy, and afford me the means of beginning at leaſt to eſtabliſh the comparative hiſtory of this liquid in the different orders of animals.

117. The following are the properties which Rouelle had deſcribed in 1773, in the urine of the horſe. It has a ſtrong peculiar ſmell, analogous to that of the urine of the cow. It is diſcharged in a turbid ſtate or quickly becomes ſo after it has been voided; its ſurface expoſed to the air becomes covered with a pellicle ſimi-

lar

) the cream of lime, which is renewed it is broken; this pellicle amounts to of its weight. A gelatinous ſediment is de-·d from it which renders this urine ropy; property is deſtroyed by agitation and ition; it turns the ſyrup of violets green, ices an effervefcence with the acids, and is ɔitated like lime-water by the alkaline car-es. There is obtained from it by analyſis tract and a ſaponaceous matter the urée, m the human urine; the ſaponaceous mat-pretty abundant in it; the extractive is ſo than in the human urine; it is black itch. He obtained from theſe two ſubſtances ıme products as from thoſe of the urine e cow, but no muriate of ammonia nor horus, as from the extract of the human

Their reſiduum contains pot-aſh, they a little from the ſame matters extracted :he human urine. The urine of the horſe s no phoſphorus: it contains ſulphate and te of pot-aſh in conſiderable abundance, eous carbonate ſoluble in the acids, which verted into lime by a ſtrong fire, and is into glaſs by the heat uſed for porcelain; ıte of lime which is precipitated with the ling earthy ſalt. He found in it no in-d pot-aſh as in the urine of the cow. It ıts, however, in its putrefaction the ſame omena as the urine of man and of the cow; ılts which it contains are not altered; but ın the extractive and ſaponaceous matters

that the putrid alterations take place. Roı promifed to afcertain them by new obfervati but he publifhed nothing upon this fu from 1773 till his death, though fince above mentioned period he has feveral t fpoken of the animal matters and efpecial the urines.

118. In analyfing the urine of the h more than twenty years after Rouelle, we l confirmed moft of his refults, and have add them feveral new facts. fhall here giv account of our labours, in order that they be compared with thofe of the illuftrious mift who had preceded us in this career. urine of the horfe, at the moment when i voided, has the fmell of hay mixed with of tranfpiration; it is ropy like a folu of gum, it is bitter and faline, and afterw a little faccharine; after violent exercife, turbid and white like milk; that which is vo in the ftables and paftures is difcharged (and becomes turbid by cooling; its fpe gravity is between 1,030, and 1,050. It turns fyrup of violets green; it effervefces with acids, and precipitates the nitrates of mer and of filver, and the muriate of barites; oxalic acid forms in it an abundant precipit as well as lime-water and the cauftic alka The folid pellicle which is formed at its fur by the contact of the air, amounts to betw 0,002 and 0,011 of the weight of the uri it contains a vegeto-animal matter with carboı

carbonate of lime, which conftitutes its bafe; for it becomes black upon ignited coals, yielding a vapour of pyromucous acid and ammonia; it froths and becomes covered with a fcum in the acids. At the fame time that this pellicle is formed, the urine of the horfe becomes coloured, and brown by fucceffive ftrata from the top to the bottom; which does not happen to it in clofe veffels. Evaporation likewife colours it; when it is reduced to a fourth of its volume, there are formed in its furface cubic, faline, pungent cryftals, that weigh nearly 0,5 of the urine. The concrete refidue of the evaporation diffolves almoft entirely in alcohol, and frequently leaves undiffolved carbonate of foda. The alcoholic folution affords by evaporation cryftals of muriate of pot-afh, and afterwards a fecond falt, which is brown and acrid, and has been afcertained to be benzoate of foda; from the folution of which in water, benzoic acid has been precipitated by muriatic acid; this fame acid is alfo found in the urine of the horfe: treated alone by the muriatic acid, it is feparated from it in cryftaline needles in the courfe of time; it amounts to 0,011 or a little more than 0,01 of the whole. When the alcoholic folution of the extract of the urine of the horfe has yielded the muriate of pot-afh and the benzoic acid by the addition of the muriatic acid, it yields by evaporation an oily pellicle of muriate of foda: reduced to the ftate of fyrup, it

concretes by cooling into solid and cryſtaline urée.

119. According to the analyſis the proceſſes of which I have juſt enumerated, the urine of the horſe has appeared to us to be formed of carbonate of lime and of ſoda, muriate of pot-aſh and of ſoda, of benzoate of ſoda and urée; it was even in this urine that we firſt recognized the urée as a peculiar matter, by its property of being precipitated in denſe and compreſſed cryſtals from the inſpiſſated urine by the aid of the nitric acid. We found it in the human urine and afterwards in the urinous liquids of ſome other animals after we had diſcovered it, as a peculiar matter, in that of the horſe.

We did not content ourſelves with thus aſcertaining the differences which exiſt between the urine of the horſe and that of man, both taken in their ſound and natural ſtate; but we purſued our examination of the firſt urine when altered by ſpontaneous decompoſition. In this ſtate it preſented to us a dark and almoſt black colour, and a very ſtrong ammoniacal ſmell; the acids precipitated benzoic acid from it with a briſk efferveſcence. It contained no more carbonate of lime; it yielded by diſtillation water charged with carbonate of ammonia, which acquired a roſe colour by the addition of the acids; after this operation it efferveſced no more with the latter; during its evaporation there was ſeparated from it an oily

oily, acrid and black pellicle. Its extract being diſſolved in alcohol, there remained acetite of ammonia, and the ſolution yielded muriate of pot-aſh and benzoate of ſoda; the muriatic acid diſengaged from it acetous acid, ſeparated from the benzoic acid, and the addition of the nitric acid did not form in it thoſe white ſilky cryſtals, which it ſeparates in abundance from the freſh urine of the horſe. Thus the differences obſerved in this fermented urine are reduced to the abſence of the carbonate of lime, of that of ſoda, of the urée, and the preſence of the acetous acid and the carbonate of ammonia. The laſt does not exiſt in this urine when not altered, and it is one of the principal products of its fermentation. The carbonate of ſoda is decompoſed in it by the acetous acid, which ſeizes upon its baſe, while it unites alſo with the ammonia. Theſe ſaline combinations oppoſe the diſengagement of gas during the fermentation of the urine. This ſpontaneous movement in it is owing to the urée, like that of the human urine, and this urinary matter is converted into ammonia, acetous and carbonic acids—a converſion which gives riſe to all the changes produced in this liquid.

120. Rouelie is the only chemiſt who has examined the urine of the cow. His enquiry publiſhed in 1773 in the Journal de Medicine, contains the following principal facts which eſtabliſh a great analogy between this urine and

and that of the horfe. The urine of the cow is unctuous to the touch, and has a ftrong and peculiar fmell. Its colour grows darker by keeping; it never has the fine amber tinge of the human urine; there are formed at its furface, that is in contact with the air, in eighteen or thirty hours, fmall oblong cryftals with regular faces. In two or three days, it depofits a gelatiniform fediment. It turns the colour of violets green; it effervefces with the acids; it is not altered by the alkaline carbonates. It contains carbonate of pot-afh, which is the caufe of its effervefcence: by adding to it weak nitric acid and afterwards evaporating it, we obtain from it needled cryftals of nitre. We alfo find in it, as in the human urine, two fubftances the one called faponaceous, the other extractive. The firft, or the urée, which is very abundant, is foluble in alcohol, affords much ammonia, by the fire, with more oil than that of human urine; but no ammoniacal muriate. Its coal is alkaline and effervefces with the acids. The extractive matter is more abundant in it than in the human urine. It affords the fame products as the faponaceous. Both are, according to Rouelle, a little different from thofe of the human urine. Befides thefe firft bodies, the urine of the cow contains fulphate of pot-afh in confiderable abundance, muriate of pot-afh and an acid analogous to the benzoic, foluble in alcohol, and which the author has believed to be decompofed by putrefaction, as he did

not

ad it again after this alterative move-
He pretends alfo that this volatile
which he does not pofitively affert to be
ne as the benzoin, does not conftantly
n the urine of the cow. He afks whether
oes not depend upon fome circumftances
'e to the nourifhment or the drink of the
l. He concludes with afferting that this
does not afford phofphorus, and contains
ofphate. He had promifed feveral other
; refpecting this urine, which he has not
hed, and which certainly have not been
in his papers, as nothing has appeared
iis death.

. However, three years and a half after
iblication of thofe interefting analyfis of
ine of the horfe and of the cow, Rouelle,
unger, gave in the Journal de Medicine,
1777, fome obfervations upon the frefh
e putrefied urine of the camel. He exa-
l it two or three hours after it had been
d. According to his examination, this
is of a dark ale-colour and a little turbid,
odorous than any other, but neverthelefs
r to that of the cow, though very
ent from that of man and of the horfe ;
ot muciliginous, and does not depofit car-
e of lime like the latter. A veffel containing
unçe of diftilled water contained 1 ounce
3 grains of the urine of the camel, 1 ounce
1 grains of that of the cow, 10 ounces
ains of that of the horfe, and 10 ounces
15 grain

15 grains of human urine: thus the urine of the camel was the heavieſt of all. It ſlightly turns the infuſion of violets green, effervesces with the acids, affords nitre, ſulphate, and muriate of pot-aſh by the addition of the nitric, ſulphuric, and muriatic acids, and by evaporation. It affords by evaporation on the water-bath one ninth of its weight of an extract in a firm maſs; a quantity more conſiderable by one third than that of the extract obtained from the urine of the cow. He concludes his examination with ſaying that the urine of the cow contains the two ſubſtances, the ſaponaceous and the extractive; that the latter is more abundant in it than in the human urine, and thus it reſembles that of the cow; and that there are alſo found in it ſulphate and muriate of pot-aſh, beſides free pot-aſh. As to the volatile ſalt, he had not diſcovered its preſence, and he admitted it to exiſt in it only by reaſon of the great analogy which he had found between this urine and that of the cow, inſomuch that he thought it difficult to diſtinguiſh them. At the end of this ſhort notice reſpecting the urine of the camel, he ſays that its coal, burned and lixiviated, affords about $\frac{1}{11}$ of the weight of the urine, of ſaline matters, and he remarks that the muriate of ammonia which he did not find in this liquid, could not actually exiſt; it is along with the fixed alkali, and that it is conſequently not from this excrementitious humour that the ſal ammonia of Egypt is obtained,

obtained, for the fabrication of which Haſſelquiſt, indeed, aſſures us that they do not employ the urine of the camel.

122. The urine of the rabbit, which has been examined by Cit. Vauquelin, preſented to him remarkable analogies with that of the three great mammiferous animals of which we have juſt been treating. This urine is turbid and becomes milky by cooling; it becomes brown in the air and ferments; it turns blue vegetable colours green, and effervefces with the acids; it precipitates the nitrate of ſilver, the muriate of barites, and the magneſian ſalts. Its ſediment, diſſolved with efferveſcence in the nitric and muriatic acids, leaves a ſmall quantity of ſulphate of lime and is precipitated by the alkalies. After fermentation it has a ſtrongly ammoniacal ſmell; it is precipitated alſo by the gall-nut, but leſs abundantly than when freſh. The fermented urine of the rabbit, when evaporated, exhales much ammonia, gives an oily pellicle at its ſurface, leaving blackiſh reſiduum from which alcohol takes up the coloured part and ſeparates a ſaline portion. The preſence of the urée is not ſo ſenſible in this urine as in the preceding kinds, and it appears to undergo a more profound or more complete alteration by fermentation, as it cannot be ſenſibly precipitated by the nitric acid. The ſaline portion not diſſolved by the alcohol, is a mixture of carbonate of pot-aſh and of ſulphate of pot-aſh; the muriate of pot-aſh and the acetite of

of ammonia, united with a colouring matter, are in ſolution in the alcohol, which preſents the firſt by evaporation, and the ſecond by diſtillation. Citizen Vauquelin gives, as the reſult of his analyſis, that the urine of the rabbit contains a very alterable urée, a gelatinous mucilage, carbonate of lime and of magneſia, carbonate of pot-aſh, ſulphate and muriate of pot-aſh, and that there is formed in it by fermentation, acetous acid, carbonic acid, and ammonia: he has not indicated the benzoic acid undoubtedly on account of the ſmall quantity of this urine, which he was able to examine; neither has he found any phoſphates in it. He admits a ſmall quantity of ſulphur in it, and he remarks, that it frequently exhales a very ſenſible ſmell of the vegetables, with which the rabbits have been fed. It cannot be doubted, according to this analyſis, that there are very great analogies between this urine, and that of the horſe, of the cow, and of the camel. The conſtant abundance of the urée; the preſence of the carbonate of lime and of pot-aſh; of the muriate and ſulphate of the ſame baſe; the abſence of the phoſphates and of the uric acid; the property of being converted into ammonia, and into acetous acid, by fermentation; theſe are ſo many characters by which this liquid approaches on the one hand, to the urine in general, as a peculiar animal humour; on the other, to that of the hairy herbivorous animals, in particular.

Though

rejected by this excretion; but this rejection is not to be confidered as the principal; and ftill lefs, as the only utility of the urinary difcharge, as was done fome years ago by phyfiologifts. It is true, that at that period, the conftituent materials of the urine were but very imperfectly known, fo that it was to the marine falt, that its faline nature was almoft exclufively attributed, and Stahl even maintained, that the phofphorus obtained from its extract belonged to that falt. It is now known that the phofphates of foda, and of ammonia, are more abundant than the muriates of the fame bafes in the human urine; and that it is for their evacuation that nature has at the fame time defigned to provide, fince the urine is always charged with them. In this kind of excretion, there is a great difference between man, and the frugivorous mammalia: the urine of the latter does not contain alkaline phofphates, and the kidneys in them are not the emunctory of thofe falts; but the hair which covers their fkin, the corneous appendages which defend their extremities, even their fweat, afford the means by which the phofphoric acid is exhaled; indeed under another form of combination. Their urine being more analogous to the nature of their nourifhment, is more alkaline than acid, and pot-afh fupplies in it, the place of the foda, of which a pretty confiderable quantity is found in the human urine.

 129. The

129. The phoſphates of lime, and of magneſia, are peculiar to the human urine; and nature, having intended theſe ſalts to be evacuated by the way of the kidneys, has rendered the former eſpecially ſoluble in their liquid, with the aid of a ſmall exceſs of phoſphoric acid. As nothing ſimilar is found in the animals, it is evident that one of the moſt important utilities of the human urine, is to evacuate the ſuperabundance of the calcareous phoſphate, or earth of the bones. Accordingly, its proportion in this urine, is always relative to the ſtate of the oſſification: there is little or none of it in the firſt age of life, in which the bones are formed, and employ all the phoſphate of lime taken in with the nouriſhment: it augments in proportion, as the bones grow harder; it is at its maximum, when theſe have attained their full growth; it increaſes, when the bones become ſoftened in various diſeaſes; and at all times, the knowledge of it is of importance to phyſiology and medicine. Inſtead of this ſalt, the principal ſource of the white ſediment, which is formed in the human urine, that of the mammalia contains carbonate of lime, which is alſo precipitated from it; and in the animals, the ſuperfluity of phoſphate of lime is conveyed into the hairs with which their ſkin is provided; into their nails; into their horns; into the different exterior appendages of their body, and even into the abundant ſweat, which violent exerciſe occaſions in them.

130. If we consider the great quantity of animal matter, peculiar to the urine, which I have designated by the name of urée; if we recollect, that it exceeds by several times the sum of all the other saline bodies dissolved in this liquid; that it gives it its colour, its smell, and its real urinary character; that without it this liquid would not be what it is; that it has been constantly found in all kinds of urine hitherto examined, it cannot be doubted that its expulsion is the principal end, the most necessary, and most remarkable purpose of the urinary evacuation. When we afterwards behold it so soluble, so alterable, or fermentescible, more especially so subject to be changed by the variation of equilibrium into carbonate of ammonia, we can no longer doubt that it is an animal matter, compounded by the vital action of the organs, carried to the last term of complicated combination, disposed by a powerful and long chemical attenuation, to separate into its first elements; in a word, a too much animalized body, carried to the *maximum* of animali ation, not susceptible of undergoing any more intimate alteration, without being decomposed and destroyed, and consequently menacing the animal organization, with an impending solution and destruction, and requiring to be evacuated by the preservative power, which presides over the support of life. Accordingly, this matter is surcharged with azote and hidrogen; and we might affirm that the too highly vitalized portion

of the blood being carried to the kidneys, is separated in their intimate texture, into two new materials, the one highly oxigenated, or the water, and the other highly azoted; the firſt, returned to the binary combination, which ſo conſtantly accompanies the laſt decompoſition of the complicated compounds; the other, aſſuming at laſt the extreme and leaſt permanent character of animalization, which renders it ſo quickly and ſo eaſily ſtructable. Thus the urine being charged with this principle, which it cauſes inceſſantly to paſs out of the body, carries off the moſt exalted animal matter; the moſt dangerous ferment for the other humours; the ſource of a putrefaction, which would looſen, and even break the thread of life, if it were retained within the body. What important views does this conſideration preſent to medicine, and what uſeful reſults may it not furniſh to the art, when the nature of the urine in putrid diſeaſes, ſhall be ſtudied?

131. The uric acid is alſo one of the excrements, which the urine conſtantly carries with it, and if we except the depoſition of the bladder of the tortoiſe, which has preſented it to Citizen Vauquelin; it appears, that the urine of man alone contains this acid matter; the moſt common ſource of the calculi of the kidneys and of the bladder; for no uric acid has hitherto been found in the urine of the other animals. However it is probable, that this acid has intimate relations with the urée, though chemical

chemical means have not yet succeeded in establishing them with precision. How does it happen, that the urée which is very abundantly contained in the urine of the mammalia, never passes into the state of uric acid? Why is this acid constant in the human urine? How is it produced there, and what particular circumstances gives rise to it in man, whilst it does not exist in the mammalia, which are otherwise so similar to man in their structure? All these are questions, which it will be possible to solve only by carefully following up that description of chemico-clinical researches, of which I have spoken above, and which certainly afford us ground to hope for their solution by these researches. The interest which they ought to excite, is founded both upon the exclusive constancy of this acid in the human urine, and upon its varied proportions in the different conditions of the animal economy, especially at the end of diseases, as well as upon the relation which appears to exist between its discharge by the bladder, in the healthy state, and its transportation towards the articulations in gouty affections of which its retention and metastasis seem to be the immediate cause. For the rest, I shall speak again of this subject in the next article, and I shall return, under other points of view, to the useful considerations, which this yet very new matter requires.

132. It must be already evident, how great an influence the chemical examination of the urine

must

muſt have upon the human phyſiology; how much greater will it appear, when I ſhall be able to cauſe this liquid to be conſidered as a critical evacuation, in a great number of diſeaſes; as replacing other evacuations in a great number of caſes, or correſponding in its abundance and varied nature with the diminution, the augmentation, and even the variations of other natural diſcharges when I ſhall ſhow, that by the changes of its properties, it becomes a ſource of more or less certain indications for appreciating what happens in many diſeaſes; that by becoming charged for example, with nutritious animal matter, either albuminous or gelatinous, as appears to take place in obſtructions of the abdomen, rickets, ſcrophula, diſeaſes of the ſtomach, phthiſics, &c. inſtead of evacuating the urée, the laſt term of animalization; the urine, in this preternatural ſtate, furniſhes the phyſician with the means of eſtimating with preciſion, the debility of the aſſimilating organs; the deficiency of nutrition: the aberration and the ever dangerous diſcharge of the alimentary juices; when, finally, according to the different changes which affect it, I ſhall find in this liquid, examined with more attention than is generally done by mere inſpection, a multitude of indications adapted for determining the preſence, the characters, and the various ſtates of ſo many morbid affections. It will undoubtedly be admitted, according to this ſlight ſketch, that if there ſtill remain many reſearches

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to be made on this fubject, they promife fo many advantages; fo many applications of immediate advantage to animal phyfiology, and already fo fuperior to thofe which could formerly be exhibited, that the influence of chemical knowledge, upon the rapid progrefs of this phyfiology can no longer remain problematical.

SECTION X.

Of the Chemical and Economical Ufes of the Urine.

154. THE very remarkable characters, and efpecially the pungent and acrid tafte, as well as the ftrong odour which the urine exhales, which fo eminently diftinguifh it from every other known fubftance, though it has hitherto always been unknown what was the origin of it, have long fince caufed this liquid to be ranked amongft the medicinal fubftances, and even amongft the moft heroic remedies. Its medicinal qualities were efpecially attributed to its faline nature; it had even been recommended in fevere difeafes, in which other remedies generally fail. Thus it paffed for a kind of fpecific in the obftructions of the abdomen, and of the liver, in the rickets, in obftinate ulcers, and in intermittent fevers, that refifted

resisted other modes of treatment. It has even been ranked amongst the most efficacious antiepiliptics, aphrodisiacs, hydragogues, and anthelmintics. Notwithstanding the high opinion which some professional men have entertained of the medicinal properties of the urine, and the encomiums which have been bestowed upon them, skilful physicians have long since renounced its use; and at present we see only some ignorant practitioners, some impudent empirics, prescribe this remedy, or some of the country people take it of their own accord, and administer it to their children.

134. The internal administration of urine, ought not however to be considered, either as an object of indifference to the art, or as a futile and ineffectual practice. Admitting some successes that have been obtained with it, but which have undoubtedly been too much boasted of, and which have taken place in difficult or desperate cases, several facts prove that urine has produced more or less violent affections, vomitings, strong diarrhoeas, even acute pains and effects, almost equal to those of poisons. When we know the nature of the urée, we cannot deny, nay, we must even naturally conceive the possibility of this action of the urine. A matter so putrefiable, so acrid, so nearly approximating to decomposition, carried to an excess of animalization, which renders it so fermentescible, may, nay must, by eluding the digestive power of the gastric and intestinal juices,

juices, give riſe to more or leſs perturbation in the living animal economy. I am even inclined to believe, that if an inconſiderate uſe were made of it for a continuance, and in too ſmall doſes for it to act very ſenſibly alone, it would gradually debilitate the vital powers, diſpoſe the humours to ſepticity; that it might give riſe to putrid diſeaſes, and threaten the animated machine with complete diſſolution. The prudence of phyſicians, which has long ſince renounced the employment of the urine, as a medicine, and which certainly is founded upon enlightened experience, is laudable and fortunate for the human race; and it muſt be left to quacks, to employ a medicine, the diſguſting qualities of which, as we ſee, are not the only inconveniences which patients have to apprehend from its uſe.

135. The employment of urine, as a topical remedy, in a great number of external affections, is ſtill much more frequent, and is not indeed accompanied with the ſame dangers, or the ſame cauſes of apprehenſion. It is uſed in caſes of burns, contuſions, cold humours, and lymphatic congeſtions; it is thought to poſſeſs a ſtrong attenuant power; it is frequently aſſociated with farinaceous ſubſtances and emollient herbs, for cataplaſms and liniments of different kinds. It has been eſpecially recommended for the burns produced by inflamed phoſphorus, and chemiſts have announced it, as being almoſt a ſpecific in this caſe. This can only be

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on account of the discutient and repercussive quality that has been observed in it. Some have also recommended its application to parts affected with gout and rheumatism; but its use may not be indifferent in this case, and I think it more prudent to abstain from it, in all cases; it ought never to be employed without precaution; and too much attention cannot be bestowed upon observing its effects. Recourse should be had to able men, well skilled in the practice of the art, for directing its employment, and moderating its activity.

136. The chemical uses of the human urine, are much more certain, and more to be recommended than its medical applications. Though this was the first substance from which phosphorus was extracted, it has not been employed for this purpose, since 1774, the period when Scheele and Gahn discovered the extraction of that combustible body, from bones. However, with the aid of some chemical preparations, we may still avail ourselves with great advantage of the phosphates contained in this liquor, for obtaining phosphorus from them. When fresh urine is precipitated with the nitrate, or acetite of lead, a deposition is formed of insoluble phosphate of lead, proceeding from the decomposition of the three phosphates of the urine; this salt, collected, very carefully washed, and immediately distilled with one-fourth of its weight of charcoal, easily yields phosphorus. The colouring matter, or the urée and

and the uric acid, which are depofited in part with the phofphate of lead, do not impede the fuccefs of this operation; they only render the products complicated by the carbonate of ammonia, which they furnifh, and contaminate the phofphorus a little by the oil which they yield in their decompofition by the fire; but the volatile faline product remains in folution in the water, in which the phofphorus comes over and is received; this is pretty eafily purified, either by diftilling it with a gentle heat, or by preffing it feveral times fucceffively under water, through a chamois-fkin. The muriate of lead, which alfo accompanies the precipitate, may be feparated by wafhing with large quantities of water, efpecially when the water is fharpened with a little muriatic acid. This fabrication of phofphorus may be practifed with advantage in houfes where a great number of perfons are collected together, by carefully accumulating their urine in troughs, precipitating it every day with a foluble falt of lead, and collecting the precipitate, till there is a fufficient quantity of it to be fubjected to diftillation. The apparatus of Pelletier, may be employed for this purpofe. The falts of zinc may be fubftituted inftead of thofe of lead; but they are dearer than the latter, and could only be employed in places where they were very abundant.

137. Another chemical ufe of urine, which is not confined to that of man, but belongs

longs equally to the urine of all animals, is th production of ammonia. By evaporating thi liquid to the confiftence of an extract, and diftilling it in proper apparatufes, a large quantity of ammoniacal carbonate is obtained. Haller has long ago indicated this ufeful application of the properties of the urine. It was formerly, propofed to employ this product in medicine, and valuable properties were attributed to it; at prefent we are better inftructed upon this fubject, and know that this carbonate of ammonia does not differ from that which is obtained from all the animal fubftances; but that when well purified, it is the fame, from whatever fubftance it has been obtained, and that it is of much greater importance, to confider its abundant production from diftilled urine, for the ufes of the manufacturers in the fabrication of ammoniacal muriate, than for medicinal preparations. Thus, for example, it would be ufeful to combine with the operations of the falt works, where the mother-waters contain muriate of lime, the extraction of the carbonate of ammonia, by the diftillation of putrefied urine. This product, united with the mother-waters, from which it would feparate carbonate of lime or chalk, would leave diffolved in it, muriate of ammonia, and this would be obtained by evaporation. We might alfo precipitate, by the ammoniacal product of the urine, a water charged with fulphate of lime, or this falt fimply diluted in water, extract the

4 fulphate

fulphate of ammonia, thus formed, and heat it with muriate of foda, in order, by the action of the elective attractions, to fublime from it, ammoniacal muriate.

138. Citizen Vauquelin and myfelf have indicated the urines of cattle, as proper for furnifhing benzoic acid; and this is another chemical ufe to which they may be applied. For this purpofe, we fhould evaporate thefe urines a little, pour into them muriatic acid, fufficiently concentrated, and wafh the white cryftalline precipitate of benzoic acid, which is obtained from them. A preliminary experiment fhould alfo be made of the urine of the mammalia, that is deftined for this operation; for it is poffible, that, according to the aliments with which the beafts are fed, that the liquid may contain too little of this acid, for it to be extracted with profit, though I do not think this circumftance frequent enough to oppofe any obftacle to the extraction of the benzoic acid; the urine which has remained in the litter, and runs off at the bottom of the dung-heaps, may alfo ferve for the fame operation.

139. The employment of urine, in the artificial preparation of nitre, is another of its moft important ufes; it contains a fufficient quantity of animal matter, to favour the production of nitric acid in putrefaction. But that of the mammiferous animals, is in this refpect, greatly preferable to that of the human fpecies. The latter contains muriate of foda and phofphates, which

which render the portion of faltpetre, which is formed in it, both very impure and very fcanty that of quadrupeds, on the contrary, has over the human urine, the great advantage of being charged with pot-afh, and muriate of pot-afh; and in proportion as the nitric acid is formed, it is converted into fufficiently pure nitre; the portion of nitrate of lime, which is formed, is alfo decompofed by the muriate of pot-afh. On this account, the herdfmen of Switzerland extract an abundant quantity of very fine faltpetre, from the putrefied litter of their cattle, and from the earth under their ftalls. In Denmark, all the farmers form artificial faltpetre-beds with the dung of their cattle, which they mix with fand, and leave to be flowly decompofed.

140. Human urine has been employed from time immemorial, for fulling and cleanfing of wool. The fullers and dyers of Rome, who by a decree of police, were banifhed from the city to the other fide of the Tiber, preferved the urine in large earthen veffels, in which they fuffered it to putrefy, as Martial informs us, in feveral of his epigrams, where he inveighs againft the naufeous fmells proceeding from their workfhops; it is ftill employed in fome countries for fimilar ufes. The human urine enters alfo into feveral compofitions for dying. With it, and by maceration, are prepared the red colour of archil, and feveral other colouring matters, with fome fpecies of lichens, the rocella, the parellus, &c.

Article XXVI.

Of the Urinary Calculi of the Human Species, and of the Arthritic Concretions.

Section I.

Of the successive Inquiries that have been made respecting Urinary Calculi.

1. THOUGH the urinary calculi, which are formed in the human kidneys and bladder, are only morbid and preternatural concretions; yet as the materials of which they are formed, are almost all contained in the urine of healthy subjects; and as their study, by throwing light upon the means of opposing their formation, or effecting their solution in the bladder, may render the very important historyof this excrementitious liquor still more complete, I have thought it proper to treat of them after the history of the urine. I have besides been induced to do so, by the interest which this study must have in the chemistry of the physiology of animals; especially since the last discoveries made upon the composition of these concretions. I shall divide what I have to say upon this subject, into eight paragraphs. In the first, I shall set forth in a few words, the history of the investigations and chemical

chemical refearches made upon the human urinary calculi; in the fecond, I fhall occupy myfelf with their feat and phyfical properties; in the third, I fhall enunciate the different materials, which conftitute them, according to the laft analyfis made by Citizen Vauquelin, and myfelf; the fourth fhall treat of their methodical claffification: the object of the fifth fhall be fome confiderations relative to their caufes and formation; the fixth fhall comprehend the examination of the folvents appropriated to these calculi; to the feventh, I fhall refer the comparifon to be eftablifhed between the urinary concretions of man, and thofe of the animals; finally, I fhall appropriate the eighth and laft paragraph to the analyfis of the arthritic concretions, in which there has long been admitted an intimate analogy with the calculi of the kidneys and bladder, though it has not as yet been fufficiently eftablifhed by their chemical examination.

2. The ancients had no accurate notions of the nature of the urinary calculi, nor could they attach any intereft to this kind of knowledge; for their notions refpecting the compofition of the different natural bodies, compared with each other, were abfolutely nothing. From Galen to Paracelfus and Van Helmont, we find nothing but fictions or hazarded opinions, in the books of medicine. Thefe two laft medical chemifts, without being better acquainted with the human urinary calculi, than thofe who had preceded

preceded them, began, however, to form fome fufpicions concerning their component principles, and to confider them as very particular matters. Paracelfus had invented the name of *duelech* for expreffing this particular nature; and he thought that the calculi were compofed of a fluid matter, and of a petrifying juice; though he well remarked, that there was an effential difference between the ftones, properly fo called, and the calculi of the bladder, which have been fo inaccurately called *ftones*. Van Helmont, in his celebrated treatife *De Lithiafi*, has introduced more of genius and imagination, than accurate refults of experiments. We owe, however, to him, the ingenious notion of comparing the vefical calculus to tartar, and one of the firft defcriptions of the effects of diftillation upon this concretion. He obtained from it, a fetid liquor; a yellow cryftalline fublimate; an oil, fimilar to that of urine, and a friable coal, little faline. A fingular approximation might be made between the refults of Van Helmont, and the modern experiments.

3. The learned Hales has much infifted, in his animal ftatics, upon the aëriform product which the calculus of the bladder furnifhes, particularly its quantity; he has explained its folidity by the prefence of this fluid, which he confidered as the cement of bodies. But this idea, which was adopted during more than 30 years, with enthufiafm, by the phyfiologifts, has been

ſubverted by the diſcoveries reſpecting the elaſtic fluids, and their differences. A multitude of phyſicians have written upon the calculus, without better determining its nature. The principal authors of this claſs, ſince Hales, till in the year 1776, were Boerhaave, Slare, Denys, Detharding, Venette, F. Hoffman, Hartley, Wyth, Morand, Palucci, Lobb, Deſſault, Lanney, Tenon, who with ſome true and well obſerved facts, upon the chemical phenomena, which the calculi of the human bladder preſent, have, however, conſigned in the annals of ſcience, nothing but errors and hypotheſes, marked from time to time by ſome uſeful views, or by ſome ingenious ideas. Margraff himſelf, the laſt whom I ſhall mention in this liſt of men, who, notwithſtanding their great talents, have made no advancement in the knowledge of the urinary calculi; Margraff, able chemiſt as he was, deſcribed in the year 1775, in the memoirs of Berlin, only the action of fire upon theſe concretions, and did not aſcertain their nature. I ſhall not here ſpeak of all thoſe men of the faculty, who have written upon pretended lithontriptics, upon ſolvents of all kinds, and who have announced only erroneous reſults, without ſaying any thing reſpecting the compoſition of the calculi; an object ſo natural, and ſo neceſſary to be determined, before ſolvents could be propoſed worthy of attention or confidence.

4. It

4. It is to Scheele, as I have already indicated in another place, that the firft, and the moft important difcovery, refpecting the human urinary calculi is to be attributed. Before him, it had been believed in a vague manner, that the matter of the calculi, was an earth analogous to that of the bones, of which alfo, no exact notion was poffeffed, as has been fhown elfewhere. The illuftrious Swedifh chemift proved, in 1776, that thefe concretions were formed by a particular, almoft infoluble acid, which the leys of cauftic fixed alkalies diffolved well, and that they contained no lime. Bergman confirmed the difcovery of Scheele, and announced, that he had obtained precifely the fame refult from his analyfis. Though this is in fact one of the fineft difcoveries that have been made in chemiftry, it is very remarkable, that Scheele pretended he had found exactly the fame principle in all the human calculi, that he has afferted, that they were all folely compofed of the fame acid matter, and that he has not had occafion to obferve fuch concretions of another nature; whereas there exift, as I fhall make appear, at leaft four other materials in the different fpecies of calculi of the human kidneys and bladder. We might be induced to think, that Scheele had never feen more than a fingle fpecies of thefe concretions, or that he had feen only a fmall number, which prefented no varieties to him in their compofition.

5. Between the period of the discoveries of Scheele, and the inquiry in which Citizen Vauquelin and myself have been engaged since 1792, a considerable number of authors have published dissertations upon the urinary calculi, some of whom have confirmed the theory of the Swedish chemist, but these are the smallest number; the others have endeavoured to combat and invalidate it; some have added to it several facts, particularly upon the variation of their materials, and especially on the presence of the phosphate of lime in those concretions. Though there are still in works of this last-mentioned kind, incorrectnesses and even very serious errors; the authors have at least, no longer confined themselves to the distinguishing the urinary calculi, by their form, their colour, their surface, their size, their hardness, and only by their physical properties, as had been done before. It is to these three classes of inquiries, that we have to refer the memoirs and dissertations of Messrs. Dobson, Percival, Falconer, and Achard, upon the lithonthriptic action of the carbonic acid, and of many others, upon the analysis of the stones of the bladder, especially of Messrs. Hartenkeil in 1785, Tychsen in 1786, Link in 1788, Titius in 1789, Walther in 1790, Brugnatelli in 1793, and Pearson in the first part of the philosophical transactions of 1798. I do not here mention a number of thesis, or academic dissertations, which have appeared

peared for twenty years paſt in the different univerſities of Germany, and in which we find nothing but repetitions or antiquated errors.

6. During this interval, being inceſſantly occupied with whatever appertained to animal chemiſtry, I had taken for one of the principal objects of my reſearches, the analyſis of concretions of all kinds; and I publiſhed at different times, in the Annales de Chemie, the reſults of my experiments. The labours of Mr. Pearſon, which eſpecially turns upon a critique on the diſcovery of Scheele, and by which he wiſhed to prove that the matter, called *lithic acid*, in the French nomenclature, was not really acid, but a kind of animal oxide, induced Citizen Vauquelin and myſelf, to reſume in the moſt extenſive manner, the chemical examination of the urinary calculi, and to compare their differences; for their aſpect alone indicated to us, that there muſt exiſt, very conſiderable differences between them. We collected upwards of five hundred different ſpecimens of theſe concretions, and their analyſis led us to unexpected reſults. We ſaw, that inſtead of a ſingle component matter of theſe calculi, which Scheele had admitted, there were four or five other different ones; that ſometimes each of theſe materials was inſulated, and that frequently ſeveral were combined to the number of two, and even of three in a ſingle calculus; that we might, with reference to this mixture, or the reſpective

respective disposition of these matters, classifi the urinary calculi in quite a different mann and with much more accuracy than had hither been done; that the acid found by Scheele, act ally existed, and ought not to be considered as mere oxide; that the name of *lithic* acid, was not a proper one, but that that of *uric* acid ought to be substituted instead of it; finally, that the lithontriptics must vary according to the nature of the calculi, and that they could not always be taken from the class of the leys of caustic alkalies, as the too limited analysis of Scheele indicated.

7. It results, in general, from the whole of these new facts, observed since the discovery of the Swedish chemist, upon the analysis of the human urinary calculi, which has at the same time been extended to that of the urinary calculi of several other animals, and of animal concretions of different parts of the body, that this part of chemical knowledge is at present much farther advanced than it was before; that we have at present very extensive notions respecting the differences of composition existing in this class of matters; that these notions, being introduced into medical science may throw the greatest light upon the formation of the different animal concretions, and upon several points of animal physiology; that all the vague ideas, all the uncertain or hypothetical theories, hitherto presented upon the origin and the nature of the calculi of the kidneys, and of the bladder,

der, diſappear and enter into the claſs of the fictions, with which this ſcience has ſo long been over-loaded; that the doctrine of the lithontriptics, or ſolvents of calculi, being reduced to its juſt value, is as much perfected, or as far advanced as the art can hope; finally, that the means of analyſing the animal concretions being now well determined, and ſufficiently varied, for appreciating their real nature, the recourſe ought no longer to be had to certain analogies which are often ſo fallacious in deſcribing theſe concretions. All theſe new data ſhall be ſet forth in the courſe of this article.

Section II.

Of the Seat, and of the Phyſical Properties of the Urinary Calculi.

8. THE urinary calculi, being formed, as their name indicates, of one or of ſeveral matters contained in the urine, may occupy any of the places which this excrementitious liquid traverſes. They are found in the pelvis of the kidneys, in the ureters, in the bladder, and in the urethra. Their concrete ſtate has cauſed them to be called ſtones, and many authors have in fact, ſo far confounded them with theſe bodies, that they attempted to explain their formation by the ſame mechaniſm. Their firſt ſeat, or the place of their original formation, being the pelvis of the kidney, where the urine filtrates, it is by the ſeparation or the cryſtallization of a ſubſtance

ſubſtance diſſolved in this liquid, and which is too quickly depoſited from it, that their concretion commences. They may, however, exiſt calculous concretions, formed originally in the ureters, the bladder, or the urethra; but theſe caſes are in general more rare, and it is eaſy to ſee, that the calculi of theſe three laſt regions moſt frequently have for their origin, calculous nuclei, that have been formed in the kidneys.

9. The renal calculi, vary much in their ſize their form, their colour, their ſurface, their denſity, and their interior texture. They are moſt frequently ſmall, concrete, roundiſh bodies ſmooth externally, brilliant and cryſtalline; of a reddiſh fawn, or wood colour, hard enough to take a poliſh, and which, on account of their ſmallneſs, readily move in the ureters and bladder, and are diſcharged by the canal of the urethra: they are then called *gravel*, which name is alſo given to the diſeaſe, in which they are voided. Sometimes the gravel are unequal granulated, rough at their ſurface, frequently even angular, prickly, pointed, and though ſmall in ſize, they then occaſion much pain and many accidents by lacerating the duct through which they paſs. In other caſes, and by a ſtill more unfavourable diſpoſition, theſe renal calculi, formed from the firſt of too large a ſize to be carried into the ureters along with the urine, remain in the pelvis, increaſe in volume, mould themſelves upon its ſides, extend themſelves by branches and ramifications into

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the firft divifions of this cavity, prefs and alter the texture of the kidney in fuch a manner, that this fuppurates, waftes away, and leaves at laft nothing more than a fort of cyft, filled with pus, and the folid concretion which has given rife to it. This cafe, indeed, prefents itfelf but rarely; neverthelefs, it is obferved in diffections of fubjects that have died in confequence of long protracted difeafes of the urinary paffages. Similar renal concretions of great bulk and hardnefs, have been found, even in perfons who had complained of no fenfation that could indicate their exiftence. The renal calculi, in thefe laft cafes, are generally of a brown, dark-red, or black colour, and covered with feveral external ftrata, proceeding from the pus or blood; fome, however, are met with, which are yellow, reddifh, cryftalline, and of a homogeneous, calculous matter. It rarely happens, that the renal calculi, whatever may be their form or fize, have a white or a grey colour. Amongft a great number, which I have had occafion to examine, I have not yet feen more than two of a mural nature, of a grey, blackifh, and afh colour, and of a compofition fimilar to what are called *mural ftones of the bladder*, of which I fhall fpeak hereafter: they are almoft always uric acid.

10. The calculi of the ureters, proceed almoft all from renal calculi, that have fallen from the kidneys into thofe ducts, and which having been too large to pafs through them, have been detained in them. Frequently they become the

nucleus or centre of larger calculi, formed b the layers, which the urine inceffantly depofi upon them; fometimes they dilate the uret in an extraordinary manner, and caufe it affume the form of a bag, which retains t urine; thefe are, in general, rather rare co cretions. There is another kind, which is ſt more rare; namely, the calculous incruftatio that form themfelves upon the fides of the ducts, when the urine is detained in them, a in the cafe that has juft been mentioned. Th internal membrane of an ureter, has been foun incrufted with a depofition, which had moulde itfelf upon this membrane; but this pheno menon is extremely rare; the incruftation i white, and formed in this cafe, of earthy phof phates. Sometimes the calculi of the ureter are perforated with a hole, which fuffers th urine to pafs through.

11. The calculi of the bladder are muc more common than the preceding. They hav been much more an object of attention, tha the calculi of the kidneys, and of the ure ters; they have been diftinguifhed by all the phyfical properties; they have been claffifie according to their fize, their form, their fur face, their hardnefs, their ftrata, &c. Thei origin, or their firft formation, is three-fold either they originate in the kidneys, and having arrived in the bladder by the ureters, they increafe in volume by the addition of fuc ceffive layers, depofited by the urine; thefe

calculi

calculi with a renal nuclens, are the moſt frequent of all; or they commence in the bladder itſelf, where they have their origin as well as their growth; or finally, they have for their baſe, or nucleus, a foreign body, introduced from without, and proceed only from ſome accident, by which this extraneous ſubſtance has been introduced into the bladder through the urethra. Theſe, which are not very rare, are eſpecially met with in women, in whom the form, the direction, and the ſmall extent of the canal of the urethra, more eaſily admit of the introduction of extraneous ſubſtances. In hoſpitals, where lithotomy is practiſed, calculi are frequently met with, which have for their baſe, pins, particles of iron, of ſteel, of braſs, of ivory, ſplinters of wood, pieces of cloth or linen. A rent, a fragment of a probe, a bullet, have alſo ſometimes given riſe to calculous depoſitions, which have ſurrounded them in the bladder.

12. Though there are a very great number of varieties of calculi of the bladder, according to their phyſical properties, theſe varieties may, however, be referred to ſome general heads, and theſe concretions may be methodically divided or diſtinguiſhed by their mere aſpect. I ſhall here conſider them with relation to their form, their volume, their colour, their ſurface, their ſpecific gravity, their ſmell, their interior texture, and their ſtrata.

A. The form, though variable in the veſſical

calculi,

calculi, is, however, moſt frequently either ſphe-roidal, or oval, or compreſſed upon two faces like almonds. Sometimes they are found poly-gonal or with facettes; this happens when there are ſeveral of them in the bladder; there are ſome even that are almoſt cubical, or cu-boid. Their extremities are frequently un-equally pointed or obtuſe. They are rarely found of a cylindroid form, and ſtill more rarely in cylinders, terminated by kinds of heads, ſup-ported upon a contracted part. There are ſome alſo in the form of ſpheroids, with two ends, and contracted or ſtrangulated at the middle: ſome have points bent backwards.

B. The volume is the circumſtance, in which the calculi of the bladder vary the moſt; ſome are only of the ſize of ſmall beans, whilſt ſome are met with, that entirely fill this organ. Thoſe of the middling ſize, and which are the moſt common, vary in bulk from that of a pigeon's to that of a hen's egg.

C. The colour deſerves to be carefully diſtin-guiſhed in theſe concretions, becauſe it indicates their nature. We muſt not confound with the proper colour of the calculi, the red or brown ſpots or coverings, which frequently pro-ceed from them. There are three kinds of colours in theſe calculi; the yellow-fawn or wood-colour, which varies in its caſt, from a kind of pale yellow, to a reddiſh or brown-red colour, ana-logous to that of ſome kinds of marble: this is the colour of the calculi formed of uric acid;

the more or lefs pure white, or greyifh-white, which always announces the earthy phofphates; and the dark-grey or blackifh, frequently with a pearl-grey caft, indicative of the oxalate of lime, which conftitutes the mural calculi. There are alfo fome vefical calculi, fhaded or fpotted with brown or dark-grey, upon a wood-yellow or white-ground. The brown or dark-grey fpots, which generally project in relievo, are the extremities of tubercles of oxalate of lime or mural calculi, placed in the centre, and as it were, cafed uric acid, when the ground is of a wood-yellow colour, or in phofphates when the ground is white. Thefe various fpecies of calculi, generally prefent the brown points only at their middle, or at one of their extremities. In the latter cafe, the mural nuclens is eccentric. What I have here enunciated, refpecting the colour of thefe concretions, is the refult of my obfervations, upon more than fix hundred calculi, thus reduced to a certain number of general claffes. Authors have defcribed green, olive-coloured, blueifh, rofe-coloured, yellow calculi; but thefe are only figns of extraneous matters, or fhades of fome of the colours that have been indicated.

D. The exterior, or the furface of the vefical calculi, prefents a great intereft to the obferver, both for the appreciation of their effects in the bladder, and for underftanding their nature. Their furface is fometimes fmooth and polifhed,

poliſhed, and then it reſembles marble ; and then it is at the ſame time of a dull wood colour. In others, it is uniform without being poliſhed ; ſometimes it is unequal, gravelly, full of ſmall rough or ſmooth tubercles, always with the ſame wood-colour. The ſame kind of calculi, ſometimes alſo preſent only one part of their ſurface ſmooth, and the reſt rugged. Some are alſo ſeen, upon which there are kinds of appendages or depoſitions of the ſame nature, in projecting tubercles or gravel. Frequently an external ſtratum, thin and interrupted in ſome points, preſents the appearance of a kind of bark or cruſt.

The white calculi are ſometimes even and ſmooth, ſometimes ſemi-tranſparent, and charged with brilliant cryſtals, and by this character, they indicate the ammoniaco-magneſian phoſphate; ſometimes they are dull, of a fine gravelly grain or roughneſs to the touch, or perforated, carious, and as it were ſpongy, and then they are formed of phoſphate of lime.

The brown or dark-grey calculi, are called *mural ſtones*, becauſe their projecting, tuberculated ſurface, frequently poliſhed and brilliant at the extremity of each tubercle, reſembles the agglomerated tubercles of mulberries. Some of theſe are found, which are fretted with elongated tubercles, projecting into ſharp points, like the prickles with which ſome ſhell-fiſh are armed. Theſe are the moſt terrible kind of calculi, on account of the excruciating pains

which

ıey excite, and the dangerous lace
rhich they produce upon they fides of
ler.

: fpecific gravity of the urinary calculi
adder has not yet been indicated: I
ghed about 500 of them, and of very
ɔecies, with much care: I have found
reight of the lighteft of them, was to
liftilled water, as 1213 to 1000; and
ıe heavieft 1976 : 1000. This denfity,
to that of water, but inferior to that
ɔf the ftones properly fo called, fhows
denomination was improperly applied
but it, however, announces, that the
alculi approach near enough to them,
ɔd to the miftake; they are frequently
ough to receive a fine polifh; they
s brittle.

dicate the fmell among the varieties of
ıli of the bladder, becaufe in fact, this
varies in them in three ways; fome-
fenfibly urinous and ammoniacal, either
y are rubbed, or when they are fawed;
s it is fimply earthy, and as it were,
ıs is frequently obferved in the white
fometimes it is perfectly fimilar to that
or ivory, when fawed or rafped, and
s to that of the fperm: the latter fmell
ntly found in the mural calculi; it
ı ferve to characterize them.

e interior texture of the vefical calculi,
es fuch variations in thefe concretions,
that

that we may be certain that we have only a very inaccurate, and very imperfect notion of their nature, when we do not faw them, and do not make the fection pafs through their centre. Their exterior furface, indeed, never accurately announces what they are internally, efpecially when they are of a fize exceeding that of a pigeon's egg. When the vefical calculi are broken, which is eafily done, either by ftriking them with a hammer, or by letting them fall from a height of one or more metres, they generally feparate into two or three layers, more or lefs thick, even, and almoft polifhed at the fractured furfaces, or only a little rugged, which fhew that they have been formed by fucceffive depofitions, at different periods. The very fine ftriated fracture, and the wood-yellow, or homogeneous reddifh colour of their interior, belong efpecially to thofe that are formed of uric acid. This texture may be ftil better feen, by fawing them; their centre is generally occupied by a nucleus of the fame nature, which is eafily detached, and their exposed internal furface, which fometimes prefents ftrata of tinges a little varied, receives a fine polifh, fimilar to that of marble or ferpentine ftones.

When the ftrata expofed by the fection, are white, femi-tranfparent, or when their fracture is lamellated and fpathic, they indicate the ammoniaco-magnefian phofphate; when very brittle, and breaking into fmall opaque and friable

layer

layers by the motion of the faw, they indicate the phofphate of lime; when very hard, difficult to be faved, refifting the inftrument, exhibiting a fmooth furface of a dark-grey colour in their fection, and exhaling a fmell of ivory; they are formed of oxalate of lime.

Frequently exterior white layers of earthy phofphates, prefent at their centre a nucleus of ellow matter, confifting of uric acid, or a entre of a brown-grey colour of mural matter. ometimes this laft-mentioned nucleus is cover-d with yellow ftriated layers of uric acid. n thefe two laft kinds of calculi of two or hree different matters, the mural centre appears, s it were, radiated in its fection. When the ucleus or centre is uric acid, covered with hite layers of phofphates, it is, on the con-rary, of a circular or oval form, but with an qual curvature, and without a radiated ftruc-ure. It is rare to fee the three layers, the ex-ernal of phofphates, the middle of uric acid, nd the central of calcareous or mural oxal-ate: and ftill more rarely thefe three bodies, iftinct in their colour, their texture, and their orm, envelope each other feveral times alter-nately, and in an order different from that which has been indicated.

It muft be evident, from this defcription of the arieties of the layers, and texture of the vefical alculi, that the comparifon of their afpect may ferve to enable us to recognize them, and to di-vide them into a certain number of diftinct fpecies.

13. It is rare for the urethra to contain calculi proper to it; this cafe however, is not without fome examples. Calculi have been feen formed in the foffa navicularis, in the vicinity of the bulb of the urethra; it has been feen, that foreign bodies that had remained in this canal, and moft frequently probes that had been left in it for fome days without being moved, became covered with white calculous incruftations. With women, who have long worn a peffary, it is pretty common to find brilliant cryftals of ammoniaco-magnefian phofphate, formed upon the part of this inftrument next to the canal of the urethra, and continually irrigated by the urine. The urine detained between the glans and the prepuce, has alfo been feveral times known to give rife to white concretions, which an unaccountable careleffnefs in the perfons afflicted with them has fuffered to grow to an extraordinary fize. In the anatomical collection of the fchool of medicine in Paris, two concretions of this kind are kept, which were obferved, and given to it by Citizen Sabbatier, one of its profeffors. In all cafes, the calculi of the urethra, formed like incruftations upon foreign bodies introduced into this canal, or produced by the long retention of the urine, are conftantly compofed of earthy phofphates, which, as has been feen in the chemical hiftory of this liquid, eafily feparate from it. There are alfo urethral calculi, that proceed from the bladder, and which

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ſis, by diſcovering that the calculi were formed by a concrete inſoluble acid, peculiar to this claſs of bodies; nevertheleſs this able chemiſt was miſtaken in believing that this acid matter univerſally conſtituted all calculi. It muſt have appeared that, after him it had been found that the phoſphate of lime conſtituted an eſſential part in the compoſition of ſeveral of them; that it had even been attempted to re-examine the acid nature of the moſt frequent calculous matter, and that it was endeavoured to conſider it as in the ſimple ſtate of animal oxide, characterized by ſpecific properties no leſs ſingular than diſtinct. It is probable, that without this laſt-mentioned opinou of Mr. Pearſon, which likewiſe coincided with the reſults of Meſſrs. Linck, Hartenkiel, Walther, &c. relative to the ſimultaneous exiſtence of the phoſphate of lime, and of the uric acid in calculi, Citizen Vauquelin and myſelf ſhould not have been led to the diſcoveries which we have made upon the much more numerous materials of the urinary calculi.

15. The reſearches in which I had formerly been engaged, from 1786 to 1793, upon concretions, and which I wiſhed to purſue; the neceſſity of aſcertaining, with much accuracy, the validity of the ideas which Mr. Pearſon had ſet forth, and of knowing whether he had good reaſons for diſputing our denomination of acid given to the veſical calculus; the certainty, already produced by my former

4 inquiries,

inquiries, that this calculus was formed of fomething more than the acid difcovered by Scheele, and the fufpicion that this matter combined with the calculous acid might itfelf be varied or multiplied; finally, the hope of determining with precifion what was to be expected from lithontriptics: fuch were the various motives which induced Citizen Vauquelin and myfelf to employ our greateft attention in the analyfis of the human urinary calculi; and after having collected feveral hundreds of them, through the affiduity and kindnefs of feveral phyficians, efpecially Citizens Sabbatier, Laffus, Pelletan, Juffieu, Boyer, Defchamps, at Paris; of Citizens Noel, of Rheims; Petits, of Lyons; Pamard of Avignon; Mauffion, of Orleans; and efpecially of Citizen Giobert, of Turin, who poffeffes a collection of feveral thoufands, of which he generoufly offered us a fhare, we employed the whole fummer of the year 6, and that of the year 7, in purfuing without intermiffion the examination and analyfis of thefe concretions.

16. As the refult of our numerous experiments, fo frequently repeated and multiplied as to leave no room either for doubt or error, inftead of two fubftances which were all that had been afcertained to exift in the human urinary calculi, previous to our labours, we found feven very diftant fubftances; namely, the uric acid; the urate of ammonia; the phofphate of lime; the ammoniaco-magnefian phofphate; the

the oxalate of lime ; filex, and an animal matter frequently variable in the different fpecies of calculi.

We gave, in a firft and very circumftantial Memoir read to the Inftitution in Vendemiaire of the year 7, all the details of the experiments that have led to the difcovery of thefe feven fubftances. If we except the uric acid and the phofphate of lime, we could not have, according to more early analyfes, any notion, or even any fufpicion of the five other fubftances which prefented themfelves to our refearches as materials of the urinary calculi. Without entering into the fame details here, I fhall explain the chemical characters of each of thefe materials, in order to fhow to chemifts and phyficians the means of diftinguifhing them hereafter, and alfo to direct my proceedings in the diftinction of the fpecies and varieties of thefe concretions.

A. *Of the Uric Acid.*

17. The uric acid difcovered by Scheele, fucceffively denominated *benzoardic acid* and *lithic acid*, previous to the appellation which I here affign to it, becaufe the firft of thefe names would give it a latitude which does not belong to it, and becaufe the fecond affociates it with ftoney fubftances from which it differs widely is very truly a particular acid, and is not to be ranked in the clafs of the oxides, as Mr.

Mr. Pearfon had believed. The following are the properties which Scheele had pointed out in it, and by which he had characterized it. The uric acid is infipid, inodorous, hard, cryftallized, almoft infoluble in cold water, foluble in feveral thoufand times its weight of boiling water, from which it feparates by cooling, in fmall yellowifh cryftals; it eafily diffolves in fixed alkaline leys: it is precipitated from them in a white powder by all the other acids, even the carbonic; it is almoft unattackable by the fulphuric and muriatic acids, foluble in the concentrated nitric acid, to which it gives a red colour; it yields in diftillation a fmall quantity of uric acid, which is fublimed without decompofition, very little oil and water, cryftallized carbonate of ammonia, and carbonic acid gas: it leaves a very black coal without alkali and without lime.

18. I fhall add to thefe characters indicated by Scheele, and according to our own particular refearches, the other properties, to the difcovery of which we have been led by a long continued inveftigation of this acid. When it is triturated with concentrated leys of pot-afh or foda it forms at firft a kind of faponaceous matter, thick, clammy, very foluble in water when it contains an excefs of alkali, little fo when this falt is neutral. The faturated urates of pot-afh and of foda are little fapid, little foluble cryftallizable. When their folution diluted with water is precipitated by the muriatic acid, the

the uric acid is obtained in fmall cryftals, aculeated, brilliant, very voluminous, litt'e coloured, and only of a flight yellowifh tinge, in comparifon with the wood colour which characterifes this acid when alone. Ammonia does not diffolve the uric acid, or diffolves it but very little and the urate of ammonia is fcarcely foluble. Lime water likewife diffolves it only in very fmall quantity. The alkaline carbonates have no action upon it. The nitric acid, whilft it diffolves it and gives it a red colour, changes its nature and converts a portion of it into oxalic acid. The colouring of the nitric folution, mentioned by Mr. Pearfon as a decifive character of what he believed to be an oxide of a particular kind, it not owing to the uric acid, but to an animal matter which accompanies it, and which feems to be a fmall portion of urée. I am warranted in adopting this opinion by the acid of nitre becoming coloured in the fame manner by the extract of urine, and by the other experiment which follows.

19. The oxigenated muriatic acid foon alters the nature of the uric acid, either when a calculus is fufpended in the acid liquid, or ftill more eafily, when oxigenated muriatic acid gas is made to pafs into water, at the bottom of which uric acid in powder is placed. Its colour becomes paler, its furface fwells, it foftens and becomes as it were gelatinous. This part difappears and foon diffolves, rendering the liquor milky. All the calculous acid undergoes

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the fame folution by fucceffive ftrata; there only remains about a fixtieth part of white flocky animal matter. By a flow and continued effervefcence, fmall bubbles of carbonic acid gas are difengaged. The liquor when well diffolved, gives by evaporation muriate of ammonia, acidulous oxalate of ammonia, both cryftallized, free muriatic acid and malic acid. Thus the oxigenated muriatic acid decompofes the uric acid, converts it into ammonia and into carbonic, oxalic, and malic acids. The firft of thefe acids is difengaged; the fecond combines with the ammonia into an acidulous falt, at the expence of the muriatic acid, part of which remains free in the liquor. As to the malic acid, it remains in the liquor, when it yields no more cryftals, and may be obtained by evaporation to drynefs. The white infoluble flocks, which form about a fixtieth or feventieth part of the uric calculus, are the fame animal matter with that which gives the red colour to the folution of this fpecies of calculus in nitric acid; and it is from a portion of this matter that the red colour and the cubic form of the cryftals of muriate of ammonia, furnifhed by the evaporation of the liquor proceed. It is to be remarked that the firft action of the oxigenated muriatic acid upon the uric acid is to convert it into ammonia and into malic acid, if but little of the re-agent is employed; that a lager dofe caufes this to pafs into the ftate of oxalic acid; and that if much

much oxigenated muriatic acid be employed, both theſe acids are completely decompoſed, and reduced to the ſtate of water and carbonic acid.

20. Another character belonging to the uric acid, is the manner in which it is affected by fire; it not only yields carbonate of ammonia by diſtillation with a naked fire; it is in part ſublimed, and furniſhes carbonic acid gas, on which Hales, miſtaking it for air, inſiſted ſo much; but it is alſo very remarkable for the ſmall quantity of oil which is formed by the action of the caloric; by the Pruſſic acid, which is developed, and which is found amongſt its products, both gaſeous and liquid; by the coal, not ſaline, though conſiderably abundant, which it leaves as its reſidue; by the ſmall quantity of water which is ſeparated from it in this analyſis by fire; by the peculiar fetid ſmell, analogous to that of burnt horn or bones, which is found in all the products of this kind of concretions; by the mixture of the ſmell of bitter almonds with this odour, which is ſo ſtriking and ſo remarkable.

All theſe facts ſhew that the uric acid is an animal compound of a very particular kind, formed of azote, of carbon, of hidrogen, and of oxigen, ſuſceptible of a conſiderable number of different alterations by chemical re-agents, eſpecially of being converted into ammonia and into four different acids, the malic, the oxalic, the Pruſſic, and the carbonic, according to the more

less advanced ſtate of its decompoſiti-
. This acid, which is entirely peculiar to imal ſubſtances, of which it is one of the cretions, when it cannot be voided with the ine, which naturally holds it in ſolution, ther becauſe it is too abundant, or becauſe ere is ſome foreign ſubſtance upon which it ay be depoſited, carries with it, in its calculous oncretion, a portion of an animal colouring atter, which gives it the wood yellow or light ed tinge, and which appears to be of the ſame ature as the urée. It even appears that the uric cid proceeds from this laſt-mentioned matter, hough I have not yet been able to determine y what change the one of theſe ſubſtances aſſes into the ſtate of the other.

B. *Of the Urate of Ammonia.*

21. THERE is reaſon to believe that the urate f ammonia, which we have found pretty frequently in the urinary calculi, was confounded previous to our inquiry with the pure uric acid. Scheele met with it without knowing it, for he has remarked, that the ſtones of the bladder frequently diffuſed ammonia during their ſolution in the leys of cauſtic fixed alkalies. This is in fact the unequivocal chemical character which diſtinguiſhes it from the pure uric acid: it diſſolves like the latter in the leys of pot-aſh or of ſoda, but its ſolution is accompanied with an abundant diſengagement of ammonia

ammonia, whilſt that of the pure uric acid takes place without any ſmell of ammonia. Its purity is aſcertained by its entire and complete ſolution in theſe leys. If there remains any thing undiſſolved, this matter is neither urate of ammonia nor uric acid: it conſequently belongs to one or other of thoſe which follow.

22. The urate of ammonia is almoſt always diſtinguiſhable by its thin and united ſtrata which are not conſtantly ſmooth; by the ſmall ſize of the calculi which it generally forms; by the colour of coffee with milk which it commonly preſents. Though it is ſometimes alone, it is moſt frequently mixed with earthy phoſphates, interpoſed between its layers, in the urinary calculi of which it forms a part. It is hardly more ſoluble in cold and hot water than the uric acid. The acids act on it in the ſame manner as on the latter, except in their previous ſaturation with its ammonia, which requires a greater quantity of acid to change its nature. The urate of ammonia is moſt frequently mixed with ammoniaco-magneſian phoſphate, as it appears to exiſt only after the formation of a quantity of ammonia, ſufficient for firſt ſaturating the native phoſphate of magneſia of the urine, and afterwards the uric acid, which is naturally free in it. Its characters are ſo ſimple, and, at the ſame time, ſo well marked, that it will be impoſſible hereafter to miſtake it.

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C. *Of the Phosphate of Lime.*

23. HITHERTO, the presence of the phosphate of lime in the urinary calculi had been indicated only in a vague manner; all that was not uric acid passed for this calcareous salt. Being obliged to distinguish this compound from five other substances, which may be found with it in these concretions, we endeavoured to find in its apparent or physical properties, and in its chemical properties, characters adapted for determining its nature without doubt, ambiguity, and error. The following is what a long habit of describing and examining the calculi has furnished us respecting these subjects.

The calculous phosphate of lime is in thin layers, friable, or of little consistency, breaking into splinters or scales under the saw, of a dirty white, or somewhat greyish colour, without lamellated or spathose crystalline form, dull, and opaque, without smell and without taste. Sometimes, instead of numerous layers that have little adhesion with each other, it presents incoherent grains, truly friable, feebly aggregated together by a rapid deposition, like the molecules of incrustations and osteocollæ: many pores and cavities are seen in it, as in a spongy texture; it never singly composes a human urinary calculus.

24. However white and pure the phosphate of lime in the vesical concretions may appear to the

the eye, it is always intimately united with a animal gelatinous matter, as in the bones; an it is on this account that it becomes black an coaly when it is ſtrongly heated: it diffuſes ſmell of burned horn or bones; it yields wate oil, and carbonate of ammonia, in the retor and leaves a coaly reſiduum. Calcined t whiteneſs, it does not yield lime, but onl phoſphate of lime, deprived of its water of cryſtal lization. It is perfectly inſoluble in cold water: when it is heated with boiling water, a portion of gelatine diſſolves in this liquid, and diffuſes a very diſtinguiſhable faint animal ſmell. All the acids, even when weakened, except the boracic and the carbonic, diſſolve this ſalt, and convert it into an acidulous phoſphate it is eſpecially by the nitric and muriatic acids that its ſolution is quickly and eaſily effected without effervescence. Fragments, or entire layers, of this calculous phoſphate, ſuſpended in either of theſe acids, diluted with water to ſuch a degree that they may be drank, leave tranſparent and cellular flakes of animal matter, in proportion as the earthy ſalt diſſolves. Its acid ſolution is precipitated by the pure alkalies and ammonia, without decompoſition; the precipitate, collected and dried, is always phoſphate of lime. When this ſalt is treated with the ſulphuric acid, a little concentrated, it forms a thick magma of ſulphate and of acid phoſphate of lime: the alkalies and alkaline carbonates have no action upon it. We have never found

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in the white calculi, or in the white ſtrata of urinary calculi, the acid phoſphate of lime, which Citizen Brugnatelli ſays, he has met with in them.

D. *Ammoniaco-magneſian Phoſphate.*

25. It has already been ſaid, that urine, kept till it becomes ammoniacal, yields tranſparent and white priſmatic cryſtals of ammoniaco-magneſian phoſphate. It appears, that it is by a ſimilar phenomenon that this ſalt, which is frequently found on the outſide or in the exterior ſtrata of urinary calculi, is formed in the bladder. The ammoniaco-magneſian phoſphate of the calculi is eaſily diſtinguiſhed by its phyſical properties: it is in lammellated, ſpathoſe, ſemi-tranſparent, hard, and coherent ſtrata; it can be ſawed very well, and does not break like the phoſphate of lime; under the ſaw it gives a fine powder, ſmooth to the touch, of a brilliant whiteneſs; whilſt that of the calcareous phoſphate is coarſe, and of a dirty dull white. It has a ſweetiſh, faint taſte, and diſſolves a little in the mouth: ſometimes it is in the form of rhomboidal brilliant cryſtals, or of ſquare glittering laminæ, diſſeminated in the cavities of other calculous matters. When it has once been well examined, and eſpecially when it has been compared with phoſphate of lime, placed by the ſide of it, it is no longer poſſible to confound or miſtake it, ſo decided and

and ſtriking are its ſenſible properties or exterior characters.

26. Its chemical properties are leſs diſtinctly marked, and leſs calculated to enable us to know it without ambiguity. Though it contains, like the phoſphate of lime, a ſmall quantity of gelatinous animal matter between its laminæ, and becomes black when it is heated, it evidently ſhows leſs of it than the former, and is more purely ſaline. It diſſolves in water, ſparingly indeed, but ſufficiently ſo for its ſolution to cryſtallize by ſpontaneous evaporation; it diſſolves more eaſily and more ſpeedily in the acids than the phoſphate of lime; weak ſulphuric acid diſſolves it completely, and forms ammoniaco-magneſian ſulphate; its fragments, ſuſpended in the nitric and muriatic acids much diluted, diſappear in them more rapidly than thoſe of the phoſphate of lime, and leave lighter and leſs abundant membranous flakes in it. Ammonia precipitates from it only light magneſian flakes, or even not them, if the ſolvent acid is in great exceſs; whereas, it renders the ſolution of calcareous phoſphate ſtrongly turbid. The leys of cauſtic fixed alkalies diſengage the ammonia from it, without retaining it in the ſolution; they take from it the phoſphoric acid, and leave the magneſia precipitated and uncombined. It was this laſt-mentioned character, of diſengaging at the ſame time ammonia without diſſolving it, and of affording magneſia as a reſidue, while the properties of an alkaline phoſ-

phoſphate were ſhewn in the ſolution, which enabled us to recogniſe this ſalt as ammoniaco-magneſian phoſphate.

E. *Of the Oxalate of Lime.*

27. WERE it required here only to deſcribe the means of determining the oxalate of lime, which forms part of the calculi, and of diſtinguiſhing it from all the other materials of which they are conſtituted, it would be almoſt ſufficient to call to mind the name of *mural ſtone*, which the concretions formed of it bear, a name which has long been adopted on account of their figure and texture. In fact, we have found this earthy inſoluble ſalt only in the calculi ſo denominated; and this ſpecies has conſtantly preſented to us oxalate of lime, united to an animal colouring matter, ſo that the ſingular form, from which they take their name, appears to be eſſentially dependent upon the nature of their compoſition. I may therefore ſay, that the calculous oxalate of lime is cryſtallized or depoſited in unequal layers, as if feſtooned, preſenting on the outſide tubercles more or leſs prominent, ſometimes pointed, ſometimes rounded, rough or poliſhed, analogous to the tubercles of mulberries, of a dark grey or brown colour without, of a dirty grey, frequently with white veins within, of a denſe, fine texture, ſuſceptible of taking the poliſh of ivory, reſembling in its fracture ſcales

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or conchoidal fragments, and exhaling, when ſawed, the faint, animal, and ſpermatic ſmell, which is omitted by bones and ivory. This is the heavieſt of the calculous matter.

28. The chemical properties of the oxalate of lime are as well marked, and as eaſy to be diſtinguiſhed as its phyſical characters. It is the only one of the materials of the calculi which gives, by calcination, a reſiduum of lime forming about a third of its weight. The acids diſſolve it with great difficulty, and its nitric ſolution ſuffers this ſalt to be precipitated, without alteration, by the addition of the alkalies. Theſe, however cauſtic they may be, have no action upon this calculous matter; but the ſolutions of alkaline carbonates of potaſh and ſoda decompoſe it completely. For this purpoſe, nothing more is required than to heat the calculous oxalate of lime in powder for ſome minutes in theſe ſolutions: the product is pulverulent carbonate of lime, eaſily diſtinguiſhable by its ſolubility with effervefcence in the acetous acid; and the ſupernatant liquors contain an alkaline oxalate, which is precipitated by the acetite of lead or of barytes, and the precipitate of which is decompoſed by the ſulphuric acid: this forming an inſoluble ſulphate of barytes or of lead, leaves the oxalic acid, which may be obtained by evaporating the ſupernatant liquor from either of theſe ſalts. There remains no uncertainty, according to this mode of analyſis, ſince there is no matter of the urinary

rary calculi, which yields fimilar refults with this kind of reagent, and becaufe the oxalate of lime is the only compound which poffeffes the chemical properties, and follows the laws of decompofition here indicated.

29. One of the characters of the calculous oxalate of lime, confifts in the abundance and the nature of the animal matter which conftantly accompanies this falt, when depofited in the bladder. It is this matter which gives it the brown, chefnut, dark-red, blackifh-grey, and foot colours; for the mural calculi are fufceptible of thefe different tinges. From it proceeds alfo the fine denfe, and clofe texture, which this concretion poffeffes. It is obtained fufficiently uncombined, when a fragment of this calculus is diffolved in weakened nitric acid, by keeping it fufpended in it by a thread; in proportion as the oxalate of lime diffolves in the acid, the animal matter, preferving the primitive form and colour of the fragment, and fwelling, becomes foft, fpungy, and remains much more denfe than the light membranous flakes left by the earthy phofphates, when treated in the fame manner. Hence we fee that this animal fubftance is more denfe, and more abundant than that which exifts in the other calculous matters. It is evident, that the fingular hardnefs of this kind of calculus, proceeds from the intimate approximation of the particles, produced by the union of the oxalate of lime with this animal compound; as we fee lime incorporated with

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the white of egg, affume a very folid ftate in chemical lutings. As to the nature of this animal matter, though we have not yet analyzed it in particular, it appears to be a mixture of albuminous matter and urée: the firft is indicated by its concretion and fparing folubility in acids, the fecond by its colour.

F. *Of the Silex.*

30. THOUGH accuftomed, for more than ten years, to find this earth in many compounds, in which it had not formerly been fufpected, we were very much aftonifhed to meet with it in the human urinary calculi. It is true, that amongft fix hundred which we analyzed at this time, with fufficient accuracy to determine well their nature and compofition, only two calculi prefented themfelves, in which we afcertained the exiftence of this earth. But this fact, which indicates at leaft the poffibility of its exiftence in the urinary calculi, and the neceffity of reckoning it amongft the number of the calculous materials, is not the lefs fingular, and in fome degree extraordinary. It was in thefe two calculi, of mixed compofition in their centre, which prefented the foliated texture, and the feftoon-formed ftrata of a mural ftone, that we difcovered this new component part of the urinary concretions. Calcined to rednefs in a filver crucible, thefe calculi loft

only

only a third of their weight, without yielding free lime; the acids in which this residue was boiled, took up nothing from it; heated and fused with four times its weight of alkali, and afterwards treated by the muriatic acid, this residue concreted into a jelly by evaporation, and presented all the characters of silex.

31. The examination of all the chemical phenomena, which these siliceous calculi presented by the action of fire, of water, of acids, and of alkalies, proved to us that the silex, which formed an essential part of them, was mixed in them with phosphate of lime, and an animal matter, analogous to that which generally accompanies the calcareous oxalate. They are likewise hard, and difficult to be sawed or pulverised; their powder, which is rough to the touch, scratches those metallic surfaces upon which it is rubbed. They diffuse an animal odour when they are burned: they give scarcely any thing to boiling water. The acids take from them only a small quantity of calcareous phosphate, which however, is not separated without difficulty from the silex, to which it intimately adheres. Neither the pure alkalies, nor the alkaline carbonates, have any action upon calculi of this kind; they dissolve hardly any part of them, and only separate from them a very small quantity of animal matter. Their true distinctive character consists in their fusibility with the caustic fixed alkalies, and in the vitrification which they experience

perience with this reagent. The abſence of the properties that belong to the other ſpecies of calculous matters hitherto treated of, added to the character juſt indicated, can leave no doubt reſpecting their peculiar nature.

G. *Of the Animal Matter.*

32. It has already been ſeen, that each of the ſix ſubſtances which form the different materials of the human calculi, is conſtantly united with an animal matter. The proof of the conſtant exiſtence of the latter is drawn, both from the property of being reduced to coal, which belongs to all calculi; from the products which they furniſh in diſtillation; from the fetid ſmell which they emit when they are burned; from the faint odour which they exhale during their decoction in water; and finally, from the light, tranſparent or ſpongy and coloured, or membranous and cellular flakes, which the fragments of calculi leave, when they are diſſolved by ſuſpending them in diluted acids. Excepting the uric acid, and the ammoniacal urate, which, as animal compounds, are reduced to coal, and changed into volatile products by the action of the fire, the four other calculous materials, the two phoſphates, the oxalate of lime and the ſilex, would preſent neither of theſe characters, were they not united with an animal ſubſtance, more complicated than

than themfelves in its compofition. Thus none of thefe materials is perfectly uncombined in the urinary calculi; none is exempt from affociation or combination with an animal matter, which feveral authors have already admitted in them, and which they have frequently confidered with juftice, as the primitive rudiment of thefe concretions; as in the bones, the gelatinous fubftance, forms the firft bafe of a kind of organic texture, in the areolae of which, the calcareous phofphate is depofited.

33. But what is remarkable in this affociation of animal fubftance, with all the different conftituent materials of the urinary calculi, is, that each of them feems to be united with a different animal matter. Sometimes albuminous, fometimes gelatinous, fometimes a mixture of both, fometimes, and even frequently, accompanied with the matter peculiar to the urine, which I have called urée; this animal rudiment feems to give a conftant character to each fpecies of calculous compound. Thus the uric acid, and the ammoniacal urate, contain a fort of albumen charged with urée: the earthy phofphates contain albumen and gelatine in a membranous or lamellated and cellular form: whilft the oxalate of lime conceals among its denfe and feftoon-formed ftrata, a more compact fpungy texture, better fupplied with a coloured and more condenfed albumen, whilft the filex, enveloped in the calculi, of a fubftance confiderably analogous to this laft, refembles

resembles also the mural calculi, both in the structure which it affects, and in the density which it acquires in these kinds of concretions.

The animal matter which exists in all the calculi, is therefore not the same in their different species; it varies according to the different materials which it accompanies, and it might be said, that there exists a sort of relation between the nature of the calculous concretion, and that of the gluten, which connects its particles. It may nevertheless, be regarded in general, as a gluey or glutinous mucilage, which connects, unites, and holds together, the acid or saline particles of which, the concrete part of the urinary calculi is principally formed.

SECTION IV.

Of the Classification of the Human Urinary Calculi.

34. THE ancient modes of classifying the calculi according to their form, their volume, their surface, their colour, &c. can no longer be sufficient at present, when, according to our last experiments, an accurate knowledge of their intimate nature has been obtained. It is very evident, that it is according to the com-

pofition of thefe concrete bodies, that they ought now to be claffified, and arranged with refpect to each other. Befides, the only object of this diftinction, is merely the methodical arrangement of the calculi, and their fimple differences of afpect, and of phyfical properties. Though thefe always accord with the chemical characters, and though the mere afpect may ferve to point out their nature, there is befides the great advantage of adding to this firft knowledge, that of the folvents appropriated to each calculous matter, or to the union of thefe matters, which muft render a claffification founded upon the well determined compofition of thefe concretions, more valuable and more ufeful.

35. When we call to mind the feven different materials which conftitute the urinary calculi, and the conftancy with which each of them is accompanied with an animal fubftance, we perceive at once, that there is not one of thefe calculi which is compofed of a fingle matter. But as the animal fubftance exifts in all, and even almoft always forms their gluten, as befides, it has not a fufficient influence upon their difference, to caufe them to vary fenfibly in their properties, I fhall pay no regard to its prefence, in claffifying thefe concretions. From a comparifon of all the facts, which the accurate analyfis of more than fix hundred calculi, has hitherto prefented to us, I find, that they may be diftinguifhed into three claffes; the firft,

firſt, of calculi formed of a ſingle ſubſtance, beſides the animal matter which connects its particles; the ſecond, always without taking this matter into conſideration, compoſed of two calculous ſubſtances; and the third containing more than two different ſubſtances, frequently even four. Theſe three claſſes comprehend together, twelve ſpecies which we have already found; they may, however, comprehend a much larger number, for it is evident that the ſix calculous materials, conſidered one by one, or in their union, two and two, three and three, four and four, would give many more ſpecies, were we to conſider all theſe poſſible combinations, as actually exiſting; but we have here to treat only of what has been hitherto found by experiment, not of what may be found hereafter.

36. Of the twelve ſpecies of calculi, which our analyſes have made us acquainted with, only three belong to the firſt claſs, namely, of thoſe formed of a ſingle calculous matter: theſe are,

First ſpecies, thoſe of uric acid;
Second, thoſe of urate of ammonia;
Third, thoſe of oxalate of lime.

Hitherto, neither the calcareous phoſphate, the ammoniaco-magneſian phoſphate, nor the ſilex, have been found uncombined.

There are ſeven ſpecies in the ſecond genus, that is to ſay, amongſt the calculi formed of two calculous materials, beſides the animal

matter, which renders their compounds ternary, as it renders the preceding binary. I difpofe thefe feven fpecies in the following manner, according to our analyfes.

Fourth fpecies: uric acid and earthy phofphates, in very diftinct ftrata.

Fifth fpecies: uric acid and earthy phofphates, intimately mixed.

Sixth fpecies: urate of ammonia and phofphates, in diftinct ftrata.

Seventh fpecies: the two preceding materials, intimately mixed.

Eighth fpecies: earthy phofphates, mixed either intimately, or in fine ftrata.

Ninth fpecies: oxalate of lime and uric acid, in diftinct ftrata.

Tenth fpecies: oxalate of lime and earthy phofphates, in diftinct ftrata.

Finally, the two laft fpecies form the third clafs, or the calculi, containing three or four calculous fubftances: viz.

Eleventh fpecies: uric acid, or urate of ammonia, earthy phofphates, and oxalate of lime.

Twelfth fpecies: uric acid, ammoniacal urate, earthy phofphates, and filex.

I fhall add to this enumeration, fome lines refpecting each fpecies in particular.

37. The calculi of uric acid, or of the firft fpecies, are the moft frequent of all, very diftinguifhable by their wood, or fawn, or reddifh colour; by their brittle, radiated, denfe, homo-

geneous, and fine texture, by their complete folubility without fmell, in the leys of cauftic fixed alkalies. They vary in fize from that of a fmall pea, to the bulk of a duck's egg, or even larger than that: their rounded, fpheroidal, compreffed, ovoid, elongated form; in their furface, which is fometimes fmooth like polifhed marble, fometimes a little rough or tuberculous, hardly ever pointed or fpinous; in their colour, which is rofy, yellowifh, fawn, light-red, light-brown, veined, uniform, fpotted with different colours, never white, grey, or black; in the number of their ftrata, which are fometimes extremely thin, fometimes very thick; they frequently feparate in a part of their thicknefs, into layers, with a polifhed furface. Their fpecific weight, is from 1,276, to 1,786; moft frequently it exceeds 1,500. The renal calculi are generally of this fpecies. Amongft 600 calculi, I have found more than 150 of pure uric acid.

38. The calculi of urate of ammonia, or of the fecond fpecies, well characterized by their folubility in the leys of fixed alkalies, like the preceding, but with an abundant difengagement of ammonia, are generally fmall, of a pale colour, like that of coffee with milk, or of a grey, inclining to this caft, formed of fine ftrata, which are eafily detached from one another, and which are fmooth at the furfaces which touch each other, almoft always containing a nucleus, from which the covering may eafily be feparated. Their moft common form

is

is ſpheroidal, elongated, compreſſed, ſometimes amygdaloid; their ſurface is generally ſmooth, never tuberculous, ſometimes brilliant and cryſtalline; their ſpecific weight is from 1,225, to 1,720: water alone diſſolves them particularly when it is hot, and when they are in the ſtate of fine powder. The acids, eſpecially the muriatic, deprive them of the ammonia, and leave the uric acid, which is afterwards ſoluble in pot-aſh, without efferveſcence; they are ſometimes found covered with pure uric acid; the exterior layer of this is generally of little thickneſs, and the greater portion of the calculus is urate of ammonia. Among the 600 calculi that were examined, the proportionate number of the individuals of this ſpecies, was one of the ſmalleſt.

39. The calculi of the oxalate of lime, or the third ſpecies are extremely diſtinguiſhable and well characterized, as I have ſaid above, by their rugged, tuberculated, fretted ſurface, armed with points or prickles, on which account they have received the name of *mural*, or *moriform* ſtones; by their external brown ſoot colour; by their hardneſs, their denſe texture, the grey tinge, the ivory poliſh of their interior, and by the ſmell of ſperm which they emit when they are ſawed. They differ more eſpecially from all the other ſpecies, by the lime which they leave after calcination, by their difficult ſolubility in the acids, their perfect inſolubility in the alkalies, and the impoſſibility of effecting

effecting their decompofition, unlefs aid of the leys of alkaline carbonates.

Though placed in the clafs of cal fingle folid matter, they contain, as I elfewhere, an abundant animal which retains their form after the o lime, which renders them folid, is they weigh between 1,428, and 1,97 bulk varies much between that o calculus, and the fize of a turkey's even a little more. However the fized and the fmall ones, are the moft varieties of this fpecies; their form is ral fpherical, or fpheroidal; their furfa is always unequal, varies fingularly points with which it is armed to the and polifhed tubercles, with which it nated in fome fpecimens. They frequ ftitute the nucleus, or centre of oth but in that cafe being covered wi calculous matter, they belong to oth Their proportion, in a number of thr that were analyzed, was found to fourth or a fifth.

40. The calculi of the fourth fpe of uric acid, and of earthy phofph from each other, are extremely e tinguifhed from all others. Th white, as it were cretaceous, friab and femi-tranfparent, according or enveloping phofphate, has a an ammoniaco-magnefian bafe,

tutes its two principal varieties. The uric acid forms their nucleus, and when they have been ſawed, theſe two kinds of very diſtinct matters are found in them; the one at their centre, and the other without. They cannot be known until after they have been ſawed. They are by no means uncommon; we have found them to amount to about a twelfth of the number which we have hitherto examined. They are alſo the moſt voluminous of all the urinary concretions; they vary from the ſize of a hen's egg, to a volume which occupies the whole bladder, and even conſiderably diſtends it. Their form is ovoid in general; frequently they are more pointed at one end than at the other. They are never prickly at their ſurface; there are frequently ſeen in them cryſtals of ammoniaco-magneſian phoſphate: ſometimes the central uric acid is covered in them with alternate layers of calcareous phoſphate, and of ammoniaco-magneſian phoſphate. Their ſpecific weight is very variable.

41. In referring to the fifth ſpecies, the urinary calculi compoſed of uric acid, and of earthy phoſphates intimately mixed, I obſerve, that it is in this ſpecies that the moſt numerous varieties are found, on account of the reſpective proportions of the three materials of which they are conſtituted; for a ſingle earthy phoſphate has never yet been met with in it, but always a mixture of phoſphate of lime, and of ammoniaco-magneſian phoſphate. It is not only by the diverſity of proportion between theſe three materials, and by that of the animal matter, that the

the varieties of this species ought to be reckoned, but also according to their respective arrangement. Sometimes, in fact, the two principal matters, the uric acid and the earthy phosphates, are separated into very thin layers, slightly distinct, but alternating from the surface to the centre, never however sufficiently distinct and unconnected, to be comparable to the preceding species; sometimes the layers of these matters are so fine, and so intimately mixed, that the eye can scarcely discern their difference, and that the analysis of each of these layers is necessary, in order to ascertain the presence of both of these materials. This is the reason why the calculi of this species, which in general are of a grey colour, frequently of a homogeneous texture, sometimes presenting strata of colour distinct or shaded between the fawn and the white, differ so much in their colour, their size, their form, and the number of their strata. Their colour is never so marked as the white of the pure phosphates, the fawn or reddish colour of the uric acid, the brown or dark-grey of the oxalate of lime; it is frequently veined, as it were marbled, disposed as in the onyx: frequently also it is of a smooth, as it were saponaceous or steatitous aspect. Some are found, in which the ammoniaco-magnesian phosphate is deposited in small crystalline grains, without any very distinct strata or beds; their form is most frequently ovoid, or irregularly spheroidal; their exterior is almost always friable, whitish, of a cretaceous appearance

ance; fo as to fuggeft the idea of their being phofphate of lime alone: they are only well afcertained by fawing them. It is this mixture which moft frequently forms the numerous polyhedral calculi, worn by friction againft each other. This fpecies of calculus is pretty frequent; the totality of the analyfis has prefented us about a fifteenth of them. Their fpecific weight varies greatly: the lighteft was 1,213, and the heavieft 1,739.

42. The fixth fpecies, formed of urate of ammonia and earthy phofphate, in diftinct and well defined layers, approaches much to the fourth fpecies in its external appearances; it prefents two matters, the one forming the nucleus, is moft frequently of ammoniacal urate; the fecond inclofing the firft, is rarely formed of ammoniaco-magnefian phofphate alone, but moft frequently of the two earthy phofphates mixed together. Sometimes the ammoniacal urate of the centre is itfelf mixed with phofphates; fometimes the external layers of phofphates contain a fmall quantity of this urate, which is itfelf, in fome varieties, mixed with pure uric acid. It is diftinguifhed from the calculi of the fourth fpecies, only by the paler colour of the ammoniacal urate, by the layers of this falt, feparable from each other, and particularly by analyfis. It differs efpecially from the fourth fpecies by its fize, which is almoft always fmaller; its fpecific weight varies between 1,312 and 1,761. It is lefs frequent than moft of the

preceding

preceding ſpecies; among ſix hundred calcı which we analyzed, we did not find one-twe tieth of this ſpecies.

43. The ſame ſalts, ammoniacal urate, aı earthy phoſphates, intimately mixed togeth and not forming a nucleus with diſtinct ſu rounding ſtrata, as in the preceding ſpeci conſtitute the ſeventh ſpecies, which great reſembles the fifth in its external characters. is diſtinguiſhed from it by being in geneı leſs yellow, by being ſomewhat lighter, aı eſpecially by the circumſtance, that when the calculi are treated with pot-aſh, which di ſolves their uric acid, much ammonia is diſeı gaged from them. The calculi of this ſevent ſpecies are rare: we found that they ſcarcel amounted to a fortieth part of thoſe which w analyzed. In examining them carefully the are frequently found in them, alternate ſtrat of urate of ammonia, of phoſphate of lime, an of ammoniaco-magneſian phoſphate, but ſ thin and fine, that they cannot be diſtinguiſhe without much attention. Generally even, an this is what particularly characterizes this ſpe cies, the layers of ammoniacal urate are no without a mixture of phoſphate, as appeaı from analyſis, and it is equally rare for thoſe c phoſphates to be without a ſmall quantity c ammoniacal urate. Theſe calculi are never ſ large as thoſe of the two preceding ſpe cies.

44. Th

44. The eighth ſpecies of calculus which I diſtinguiſh, is formed of the two earthy phoſphates mixed together; namely, the phoſphate of lime, and the ammoniaco-magneſian phoſphate. This ſpecies is very well characterized, and very eaſy to be diſtinguiſhed by its pure white colour, without any admixture of yellow, fawn, red, or blackiſh grey. Its friable nature, its inſolubility by the alkalies, its ſolubility even in the weak acids, alſo characterize it with certainty. The varieties of this ſpecies, which is ſufficiently numerous, ſince amongſt ſix hundred calculi that were examined, nearly forty of them were found, are diſtinguiſhed by their bulk, which is ſometimes enormous, by the irregularity of their form, which is rarely round, frequently unequal externally, by the appearance of a rapidly-formed concretion or incruſtation, by a texture formed of white opaque ſtrata, eaſy to be cruſhed, that whiten all ſtuffs like chalk, ſometimes mixed with or interrupted by other more denſe, ſemi-tranſparent, and ſpathoſe layers, or by real tranſparent cryſtals of ammoniaco-magneſian phoſphate. The analyſis, whilſt it preſents only theſe two ſalts, exhibits a great variety of proportions between them, but never only a ſingle one of them, as I have already obſerved. Of this ſpecies are the concretions, in depoſition or in incruſtations, which are conſtantly formed upon the foreign ſubſtances, introduced through the urethra into the bladder. Their ſpecific weight varies from

 1,138 to

1,138 to 1,471. They form in general one the lighteſt ſpecies of the urinary calculi.

45. I rank in the ninth ſpecies, the mix calculi, containing in the centre a mural n cleus of calcareous oxalate, covered with u acid, more or leſs abundant and thick. E ternally, they are not diſtinguiſhed from th of the firſt ſpecies, as both preſent the ſa appearances, the ſame varieties of form, colour, and of ſurface. They are known on by ſawing them, and thus expoſing their ce tre. The dark-grey or blackiſh-brown, t ſtellated or radiated figure of their morifor nucleus, the fawn-coloured, yellow, or reddi layers of uric acid which cover it, afford the at the firſt aſpect, an accurate and certain kno ledge of their nature. The ſame varieties a found in them, as in thoſe of the firſt ſpecie Their ſpecific weight varies from 1,341 to 1,75 theſe two extremes are ſo remote from each othe on account of the great variety of proportio of the two conſtituent materials which th contain. We may even diſtinguiſh theſe v rieties by the ſection, according to the relati thickneſs of the layers. More frequently t oxalate of lime in them, is completely, or e tirely surrounded and covered with uric aci and occupies the centre, ſo that its preſen would not be ſuſpected, from the external a pearance of the calculi. Sometimes the nucle of mural oxalate is excentric placed at one the focuſes of the ellipſis of the calculi, wh

ha

have this elliptical form; ſo that the moriform tubercles come on one ſide, as far as the outer part of theſe calculi, and there form ſpots or kinds of projecting buttons, which render their ſurface rough or mottled at this extremity. This variety is much leſs frequent than that of the preceding ſtructure: amongſt ſix hundred calculi, twenty preſented themſelves of this ſpecies, and amongſt theſe, only four had the oxalate in an excentric ſituation.

46. To the tenth ſpecies, belong the calculi compoſed of oxalate of lime and earthy phoſphates; the firſt placed at the centre and forming the nucleus, the ſecond enveloping the oxalate of lime, and preſenting themſelves at the exterior part, ſo that they might be confounded by their aſpect, with the fourth and eighth ſpecies, if their interior were not examined after ſawing them. When it has been once opened, this ſpecies can no longer be confounded with any other; the exterior white, and as it were, chalky ſtrata, enable us to recognize it with facility and certainty. Next to the calculi of pure uric acid, thoſe of this ſpecies have preſented themſelves to us, almoſt the moſt frequently in our analyſis. They form about a fifteenth of the number of calculi, that we have examined. Their ſize and form vary remarkably; their external colour is always white. Frequently, their oxalate of lime is placed in an excentric ſituation; however, it rarely extends itſelf to the outſide of the calculus.

culus. The ſpecific weight of theſe calculi is likewiſe very variable: I have found them to weigh from 1,168 to 1,752.

47. The eleventh ſpecies is formed of the mixture of three or four calculous materials, namely, of the uric acid alone, or mixed with urate of ammonia, of oxalate of lime and earthy phoſphates. This is one of the leaſt common calculi, ſince amongſt ſix hundred, we have only found eight or ten of them. This ſpecies frequently preſents three very diſtinct ſtrata, the centre or nucleus of oxalate of lime, the intermediate ſtratum of uric acid, or ammoniacal urate, and the exterior of earthy phoſphates, generally mixed with uric acid, or ammoniacal urate. It can only be known by ſawing it, as its ſurface preſents only phoſphates; there is reaſon to believe, that calculi *will* be found formed of theſe three or four matters, mixed together more intimately, and not diſtinguiſhable by the diverſity and ſeparation of their ſtrata, Three principal varieties of this ſpecies may be diſtinguiſhed; that which is formed of oxalate of lime, of uric acid, and of phoſphates; that which contains urate of ammonia, mixed with the two other matters, without free uric acid, and that, which, with theſe two matters, contains at the ſame time both free uric acid, and urate of ammonia, mixe with earthy phoſphates. We might alſo ſep rate theſe calculi into thoſe with diſtinct ſtrat or with three or four matters, intimately mix

togeth

together, thofe in which the pure phofphates envelope the two other matters, and thofe in which the phofphates are themfelves mixed with uric acid, or with urate of ammonia, and even with thefe two bodies together. We have found fome of all thefe kinds; but thefe diftinctions, which might ftill be multiplied, are too refined, and of too little importance for the purpofes of the art. It is fufficient to remark, that the more the component parts are multiplied, the more numerous the varieties of their mixture muft be.

48. Finally, I place in the twelfth and laft fpecies, the calculi of complicated compofition, in which the filex feems to hold the place of the oxalate of lime; thefe are mixed with uric acid, and urate of ammonia, and is covered with earthy phofphate. I make a particular fpecies of thefe, on account of the prefence of the filex, an unexpected matter, in fome degree, foreign to the urinary concretions. Though this fingularity feems to authorize the diftinction which I here admit, I muft, however, obferve, that thefe calculi, in part filiceous, approach nearly, in their compofition, to the preceding fpecies. This is the rareft fpecies of all; amongft fix hundred, we have met with only two of this nature. It may alfo contain oxalate of lime; and thus conftitute a calculus, which contains all the calculous materials hitherto difcovered.

SECTION

tions ſince theſe two facts prove, that it may be found in them?

55. If I were inclined to purſue the ſame reaſoning upon each of the twelve ſpecies of calculi, which I have diſtinguiſhed, it would be ſtill more embarraſſing to determine the cauſes, which occaſion to be depoſited, almoſt at once, or in very cloſe, and very varied layers, the uric acid, the urate of ammonia, the oxalate of lime, and the earthy phoſphates, which appear, eſpecially in the eleventh ſpecies, to be intimately mixed, and conſequently to be ſeparated together from the urine, to form thoſe complicated concretions, which combine in themſelves all the calculous materials. It is ſufficient that I have pointed out, how many obſervations remain to be made, and inquiries inſtituted; and what minute and perſevering attention, is requiſite in this branch of the art, which has acquired ſo new an aſpect, ſince our analyſis of the calculi. The chemical examination, and the exact analyſis of the urine of calculous patients of different ages, and in different circumſtances, can alone ſatisfy all theſe important queſtions; and already, inveſtigations of this kind, have preſented to us, ſome happy reſults, which I ſhall indicate, in treating of the lithontriptics, or the means of diſſolving the calculi of the bladder.

they might depofit themfelves, in order to give rife to the calculus of the kidneys, and of the bladder.

50. This is in fact, proved by the two frequent circumftance of extraneous bodies, introduced into the laft-mentioned organ, and even into the urethra. But we have obferved, that in thefe cafes, the accidental, and in fome fort, artificial calculus which is formed, is almoft always white, and compofed of earthy phofphates. All urine indeed contains uric acid, and confequently that which forms the moft frequent fpecies of calculus; however, the nuclei introduced from without, hardly ever becomes covered with it; and it is remarked, that the individuals, in whom this uric calculus is met with, never prefent it, except formed upon an interior nucleus, upon a gravelly original that has defcended or fallen from the kidney. It is therefore neceffary, that there fhould be a particular caufe to give rife to this formation. Undoubtedly, the fuperabundance of uric acid, which takes place in calculous fubjects, its production in greater quantity than in the natural ftate, muft be allowed to be the firft, and moft certain of thefe caufes, efpecially when we confider the rapidity with which this calculus frequently increafes. But this caufe alone is not fufficient; and if it exifted infulated, we fhould fee in it only a fource of precipitation of the urine, without finding in it, that of the concretion, and the tendency to form folid layers.

51. More-

51. Moreover, there is required the preſence of a coagulating matter, which had formerly been diſtinguiſhed as lapidific, and which being abundantly diſſolved in the urine, is at the ſame time, extremely diſpoſed to ſeparate, and precipitate itſelf from it, carrying along with it, and glueing together the ſolidifiable, and frequently cryſtalline particles, which are at the ſame time, ſeparated from it. This is undoubtedly the animal matter, that is found in all the calculi, of whatever nature they may be; for it conſtantly exiſts with one or other of the calculous materials, as we have found it in all theſe materials. It is this which forms the connecting part, or the ground-work of the calculi, in the ſame manner as the membranous gelatine forms the primitive organ of the bones. This is ſo true, that the urine of calculous patients is generally thick, ropy, mucous, and as it were, charged with glairy matter; and, that when it does not preſent this character, immediately after being voided out of the bladder, it ſpeedily aſſumes it, either at the ſame moment when the ammonia is formed in it, or by the addition of the alkalies, which ſeparate this animal ſubſtance from the acid which appears to hold it in ſolution.

52. It ſeems beſides, that in all the caſes in which the uric acid is very abundant, the urine at the ſame time contains a large quantity of the animal matter, which accelerates its precipitation, which attracts it in its ſeparation, and which

which closely agglutinates its particles. Hence it follows, that all that is capable of augmenting the proportion of this species of mucous gluten in the urine, may be considered as a remote cause of the formation of the urinary calculus; and thus all the ancient notions of the physicians, respecting the pituitous temperament, and the abundance of glairy matter, which they considered as tending to the production of calculi of the bladder, upon the ground-work or the gluten of stones, or animal concretions, correspond in an exact manner, with the new notions, which the analysis of the urinary calculi affords at present, respecting the nature of these concretions. Though there is a real difference between the animal matters, contained in the urinary calculi of different compositions, it is nevertheless certain, that each of the calculous substances, containing an animal gluten, to which it owes its concrete and solid state, we cannot refuse to consider this superabundance of agglutinating animal matter, as the first and principal cause of the formation of the calculi.

53. Amongst the causes which influence the formation of the urinary calculi, the most remarkable perhaps, and the most difficult to be discovered, is incontestibly that which relates to the diversity of their nature, and the difference of the successive strata, which constitute them. As yet, I know nothing at all respecting the production of the calculi of oxalate

lemonade, and to be hardly more acrid than the urine itſelf, ſoften and diſſolve with even more rapidity the calcareous and ammoniaco-magneſian phoſphates. Theſe native matters, in fragments or ſtrata of calculi, when ſuſpended by means of a hair or thread in the above-mentioned liquors, melt, become lighter, riſe towards the ſurface, and ſoon leave in their place only ſome tranſparent flakes, ſimilar to the mucous lamellæ, which float upon the ſurface of the liquor. The preſence of the uric acid, diſſolved in the ley of pot-aſh, is demonſtrated by the addition of a weak acid, and even of vinegar, which precipitates it in a white powder; and that of the phoſphates in the acids, by ammonia, which ſeparates them.

As to the calculi of calcareous oxalate or the mural calculi, they are the moſt difficult of ſolution by weak re-agents. They, however, become ſoft and even melt almoſt entirely, with the exception of a ſpongy and browniſh animal matter, in the nitric acid diluted with water; but they require a much longer time for their ſolution than the preceding. We may alſo effect their ſolution in a ley of carbonate of pot-aſh or ſoda, which decompoſes the calcareous oxalate by double elective attractions; carbonate of lime is depoſited at the bottom of the liquor, which retains the oxalate of pot-aſh or of ſoda in ſolution.

59. One

59. One or other of the liquid re-agents that ıve been indicated, when injected into the adder of a calculous patient, muſt therefore t upon the urinary calculus and effect its lution, if nothing oppoſes its effect. Neverelefs, in this injection of the lithontriptics or lvents of the calculi of the bladder, three inds of difficulties preſent themſelves, which is neceſſary to know and to appreciate in rder to endeavour to remedy them. The firſt , to determine the nature of the calculous xiſting in the bladder. The variety of theſe oncretions, even that of the different layers hich ſo frequently form them, ſeems to oppoſe n obſtacle to the ſucceſs of theſe ſolvents, the mployment of which cannot be adviſed, nor a roper choice made till after the calculous ſubtance upon which we wiſh to cauſe them to act as been determined. The ſecond conſiſts in he neceſſity of preventing any action of the olvent upon the bladder, and confining it olely to the calculus; the third relates to the nixture of the re-agent with the urine, which ay modify it, annihilate its effects, or acompany them with ſome inconveniences detrimental to its action upon the calculus. Let us onſider each of theſe difficulties, and prove hat they do not preſent an inſurmountable obacle to the ſolution of the urinary calculi in e human bladder.

60. We have but few means of determining om exterior indications the nature of a calcu-

lus contained in the bladder. Sounding wi
the catheter affords pretty accurate indicatio
of its volume, its hardneſs, its uniform or roug
and fretted ſurface, but it diſcovers nothin
with reſpect to its compoſition. No ſymptor
as yet furniſhes the ſlighteſt notion on this ſul
ject: and in fact no regard has yet been paic
in external or operative medicine, to the diffe
ent component materials of the calculi: th
idea of ſearching for lithontriptics has never y
been founded, as it ought to have been, upo
the diverſity of the nature of theſe concretion
In this abſolute ſilence of the art upon this ſul
ject, we have thought that the examination of th
urine of the calculous patients might afford u
ſome light reſpecting the ſpecies of their calcul
and we have founded our ſuppoſitions upon th
circumſtance that this urine ought to contai
at leaſt the ſubſtance which is inceſſantly adde
to the exterior of the veſical concretion
The examination of the urine of two calculou
patients has already preſented to us either
very ſenſible diminution, or an almoſt total al
ſence of the uric acid which is generally co
tained in healthy urine: and we have thenc
concluded that their calculi were formed
this acid. In one of them, who died of ag
miſery and weakneſs, the opening of the bod
actually preſented to us a calculus of uric acic
But this point is ſtill new, and ulterior reſea
ches are neceſſary in order to confirm or inval
date this ſuppoſition.

61. Th

61. The gravel voided before or after the ſymptons of the preſence of calculus in the bladder, may alſo afford a notion of the nature of this calculus. We may alſo derive information from the calculi which the parents, children or brothers in the families of the patients, have either evacuated naturally, or which have been extracted from them by an operation. For it is reaſonable to believe that the hereditary diſpoſition to this diſeaſe proceeds from a uniform cauſe in ſuch families, and conſequently that the calculous matter is general or of the ſame nature in them. It is here to be obſerved that the uric acid and the ammoniacal urate being the moſt frequent of all the calculous materials, and being, as it appears, at leaſt in the proportion of a third of the whole of theſe concretions, whilſt the two other thirds are compoſed from among the three other calculous matters, the two earthy phoſphates and the oxalate of lime (for the ſilex, is ſo rare, that it ought ſcarcely to be reckoned amongſt theſe materials) ; it is evident that the ley of pot-aſh will moſt frequently be the proper ſolvent to be choſen. Moreover the uſe of this ley in injection cannot long leave us in uncertainty with regard to its effect, and conſequently with regard to the nature of the calculus. The diminution of the ſymptoms which it produces, and that of the volume of the calculi, whi h may be aſcertained by ſounding, ſoon ſhow whether the right ſolvent has been

been chofen. In the contrary cafe, recourfe to be had to the acids.

62. There is another method of afcertaining t] nature of the calculus contained in the bladd« and of the folvent that ought to be injecte It is that of examining this folvent after t firft injections, and after it has remained for quarters of an hour in the bladder. Firft] very weak ley of pot-afh be employed, whi has however been previoufly found able diffolve the uric calculus, by fufpending one a ley of the fame kind out of the body; let be collected half an hour or three quarters an hour after it has remained in the bladde let it depofit fome flakes which it generali contains, and of which I am immediatel about to fpeak; or let it be filtered through ur fized paper, and let a little muriatic acid l poured upon it. If this ley has met with calculus of uric acid, and if it has begun to di folve it, the addition of the acid will produce i it a fenfible white precipitate. This experimei continued during feveral fucceffive days, and each of the injections, muft afcertain in a pofiti manner the acid nature of the calculus; and may even be conceived that if it were conftant performed upon all the portions of alkaline le injected into the bladder, we might dete mine the quantity of this acid taken each da from the calculus, and go on as far the happy moment, when the patient, bein alfo freed from the embarraffing sympton arifing from the exiftence of this body, an tl

the catheter no longer announcing its prefence, the injected liquor muft ceafe to indicate the uric acid, and fhow with certainty the complete folution of the vefical calculus.

63. It is eafy to conceive, that if the alkaline ley at its difcharge from the bladder, does not give any trace of uric acid; if after its action has been continued for fome days, it perfifts in prefenting none; if the fymptoms remain obftinate in all their intenfity, there is reafon to believe that the calculus is not formed by this acid, and we are authorized to direct our views towards the injection of the weakened muriatic acid. This, as it acts very fpeedily upon the phofphates, if fuch is the nature of the calculus, or of its exterior ftrata, will foon prefent the proofs of its action. When tried, after its difcharge from the bladder with fome drops of ammonia or pot-afh, it will give a white precipitate of phofphate of lime, abandoned by the acid, in proportion as the added alkali faturates it. The relief produced by the fpeedy diminution of the calculus, will, in this cafe, quickly follow the action of the injected acid; for our experiments fhow us, that of all the calculous matters, the earthy phofphates are the moft fpeedily foluble in the muriatic acid. If two matters difpofed alternately, form the calculus, for inftance, the earthy phofphates without, and the uric acid at the centre, which happens pretty frequently, the action of the

the acid injected, will ceafe at the end of a certain time; this will be perceived by examining the liquor, after its difcharge from the bladder, and by its not being precipitated on the addition of ammonia; it will then be neceffary to have recourfe to the alkaline ley, in order to complete the folution of the acid nucleus of the calculus.

64. The difcovery of the mural calculi of calcareous oxalate, contained in the bladder, is ftill more difficult than that of the preceding; the urine is not fufceptible of exhibiting any other indications of them, except its turbid nature at the moment of its difcharge, and the analyfis, by which we muft find the oxalate in its precipitate. But no urine of this kind has yet been met with in calculous patients, or at leaft, none has been analyzed. Without denying that this may exift, efpecially in the urine of certain calculous patients, which is difcharged white and turbid from their bladder, we fhall not be able to confirm this notion, except by an examination, purfued for a fufficient length of time, of thefe excrementitious liquids, in perfons afflicted with the calculus. Such an examination cannot be made, with the attention and the feries of experiments, which it requires, except in a houfe deftined for refearches of this kind. It will be in this manner, that we fhall be able to afcertain, whether the prefence of an oxali-calcareous calculus, is capable of being

afcertained

afcertained in the bladder of a calculous patient, by the analyfis of his urine; and whether the nitric acid and the carbonate of pot-afh, injected into this organ, will be capable of effecting its folution, as we have feen thefe folvents act out of the body, upon the mural and oxalic calculi, which we have fufpended in them. Such inquiries are too interefting to humanity, not to induce us to hope, that they will fooner or later, be promoted by the public power, and that a national eftablifhment will one day be confecrated to them.

65. It has been feared, and not without fome appearance of reafon, that liquors capable of acting upon fuch denfe urinary calculi, the folution of which has fo long been confidered as impoffible, might firft exert their energy upon the coats of the bladder, and diforganize or deftroy it, inftead of diffolving the concretions, which this membranous and mufcular vifcus contains. Such an unfortunate occurrence, which is afferted to have taken place in fome imprudent trials, in which too highly concentrated alkaline leys, or acids, have been employed, is however, not difficult to be avoided, and the following are the precautions which we have taken for the purpofe. The folutions of pot-afh, or the acid liquors, were fo much diluted with water, fo much weakened, that they not only had merely a flight tafte, very eafily fupportable in the mouth, but that their

their acrimony was alfo not more fenfible than that which characterizes the urine, in order that the delicate ftructure of the bladder might fuftain no injury from their active property. Thus I have already feen five perfons ufe alkaline injections, without experiencing pain, fatigue, or even any fenfation, which could either have apprifed them of the prefence of a matter, different from the urine in this vifcus, or have afforded ground for the leaft apprehenfion, on account of the ftay which this folvent had made in it. I have obferved, that the acidulous muriatic injection, though as weak as lemonade, was always more fenfible to the bladder, than that of the alkali, and that it excited a propenfity to make water, and an irritation, an excitement to contraction and fpafm, which did not permit it to remain there for fo great a length of time. But fortunately, this acid, even when reduced to extreme weaknefs, eafily diffolves the calculous phofphates, and it is not neceffary that it fhould remain fo long in the bladder as the alkali, the action of which, upon the uric acid, is flower, and more difficult.

66. A third confideration refpecting the folvents of the calculi, has for its object, the influence which thefe folvents exercife upon the urine, and that which they may receive from this liquid. In former difcuffions, fimilar to this, it has been prefumed, either that the urine oppofed

pofed their folvent and lithontriptic quality, or that it was precipitated by them in fuch a manner, as to become more calculous, giving reafon to apprehend, rather the augmentation than the diminution of the calculi; or at leaft, caufing the precipitate which they occafioned in it, to be unjuftly confidered as the matter taken from the calculi themfelves. In fact, that the alkali muft find in the urine, free phofphoric and uric acids, which would abforb and faturate it, fooner than fuffer it to act upon the calculi: accordingly, the urine muft be an obftacle to its folvent quality. But there are two means of removing this obftacle to the fuccefs of the lithontriptics: the one is, not to inject the alkaline ley, till after having evacuated all the urine contained in the bladder, and after having wafhed it with luke-warm water. Then this ley can only be weakened by the urine, which fhall arrive by the ureters, and this effect may be diminifhed by the fecond means, which may even caufe it to ceafe altogether, and which confifts in giving the calculous patient cauftic pot-afh, extremely diluted to drink. Experiments made at Dijon and Paris, have already proved, that after the internal ufe of the pure alkali has been continued for fome days, the urine ceafes to be acid, is becomes alkaline, and thus acquires a character analogous to that of the injection, fo as no longer to oppofe its effect. It has even been hoped to give it by this means a fufficient degree

degree of alkalinity to render it a ſolvent of the calculus, and thus to effect its ſolution : though it may be very difficult to obtain complete ſucceſs by this means, at leaſt upon calculi ſomewhat voluminous, I cannot, however, refuſe my confidence to it, either for diſſolving the renal calculi, curing the gravel, or preventing the augmentation of the calculi of uric acid, and giving to the urine, a character favourable to the action of the alkaline ſolvent, injected into the bladder.

67. The alkaline ley, injected into the bladder, when it meets with the urine, there produces ſtill another effect in it, which embarraſſes its operation. When this liquor is acid, in proportion as the ley ſaturates it, it ſeparates from it a gelatinous matter, which the phoſphoric acid rendered ſoluble in it, and which is precipitated from it in mucous flocks. Theſe flocks, which I have conſtantly obſerved in the five ſubjects treated by this proceſs, are ſometimes in viſcous filaments, ſimilar to what is called glairy matter; or they form ſmall thick bodies, which collect about the eyes of the catheter, and greatly impede the paſſage of the urine, ſo that it is neceſſary to agitate this inſtrument, and introduce a ſtilette into it, in order to remove this ſlight obſtacle, and render the flow of the urine more free,

The very weak muriatic acid, injected into the bladder, has not this inconvenience; on the

contrary, it gives more tranſparence and pidity to the urine of calculous patients, n it naturally has; it even prevents the pre- itation of the glairy matter, which is ſo quently ſeen in it, and which eſpecially ac- npanies the ammoniacal ſtate of the urine, ich is ſometimes found in thoſe patients, and this very circumſtance, it oppoſes the for- tion and the concretion of the ammoniaco- gneſian phoſphate, for the ſolution of which s eſpecially employed.

3. The alkaline or acid liquors, deſtined to ve as ſolvents of the calculi of different na- res, ought to be injected into the bladder, at emperature of about 25 degrees. A catheter elaſtic gum, and a tin ſyringe, are all the paratus neceſſary for this operation. As the jections, repeated at firſt three or four times lay, afterwards ſix or eight times, and each naining from a quarter of an hour to an hour leaſt, in the bladder, muſt be long continued, d conſequently require a ſpace of ſeveral nths for diſſolving theſe calculi, it is ne- ſſary that the patients ſhould keep the catheter tionary, and uſe themſelves to perform the ections without help. They will thus avoid repetition of the pain, which is excited by introduction of the catheter, eſpecially in organ irritated by the preſence of a foreign ſtance, and much more ſenſible than in its ural ſtate. They will ſoon become fami- liarized

ſhops, and collections of materia medica, under the name of occidental bezoars, are more commonly ſtomachal or inteſtinal concretions, than urinary calculi; I have examined about ſixty of them, grey, greeniſh, and yellowiſh, and I have found in almoſt all of them, ſtrata, eaſy to be detached from each other, on account of their poliſhed ſurfaces, formed of cryſtalline filaments or lamellæ, like ſtalactites, having at their centre pieces of wood, fragments of bark, leaves, or ſmall portions of branches, upon which their ſtrata were depoſited.

71. The obſervation which I have juſt mentioned, proves, that when we take the common and pharmaceutical bezoars, as ſubjects of analyſis, we moſt frequently examine inteſtinal calculi, and that ſcarcely any is urinary or veſical. I never had but three well aſcertained opportunities to examine this laſt ſpecies of calculus, namely that of the horſe, that of the hog, and that of the bullock. The firſt were given me by veterinary artiſts, who had extracted them themſelves, either from the kidneys, or from the bladder of horſes that had died of diſeaſe. We are not to confound with theſe, the concretions ſometimes very voluminous, which naturaliſts call hippolithes, and which are formed in the inteſtine of the horſe: theſe are compoſed of ammoniaco-magneſian phoſphate, and calcareous phoſphate, whilſt thoſe of the kidneys and of the bladder of this animal, are compoſed of carbonate of lime, and ſoluble with

phosphate, or of calcareous phosphate. Frequently, this last salt has been found in the acidulous state, in the analyses which I have made of them. Thus, there exists an essential difference between the intestinal calculi, and the urinary calculi of animals, and this difference accords with that which also exists between the urine of these animals, and the human urine. As the first contains carbonate of lime, instead of the earthy phosphates contained in the second, the deposition which it forms in its canals, is only the first of these salts, whilst in the human bladder it is frequently composed of phosphates. But animals are much more subject than man, to concretions of the stomach and intestines, and these concretions are constantly owing to depositions and crystallizations of earthy phosphates, occasioned by these salts being more abundantly diffused, and as it were, cantoned in the organs of digestion, in these beings, whereas in man they are determined towards the urinary passages, which are their natural emunctory.

75. A still more singular difference is met with between the urinary concretions of animals, and those of man. In the first, we find nothing similar to the uric acid, which is the most abundant and most frequent of the materials of the human calculi. It appears that this singular matter is exclusively prepared, and formed in the body of man, though its constituent principles equally exist in that of all the

animals. The caufe of the peculiarity of this formation to man, muft confift in the difference of his organs, and of his liquids; but we have as yet, too little knowledge refpecting this difference, to be able to explain upon what this exclufive property depends. We are not even acquainted with the relation which muft fubfift between the humours of the human body, and the uric acid, which proceeds from the alteration of fome of them. Perhaps indeed, it may be formed alfo in animals; perhaps it may be contained in their urine, but in fo fmall a quantity, that it has hitherto efcaped the moft careful analyfes. The difcovery which Citizen Vauquelin has made of a fmall quantity of uric acid in the bladder of a tortoife, fhould feem to authorize this laft opinion. Perhaps alfo, the uric acid will at fome future time be found in the body of animals, but in fome other organ than the kidneys, or in fome other liquid than the urine. This acid has been thus met with in man, in other parts befides the urinary organs, as I fhall fhow hereafter.

76. The oxalate of lime, the moft frequent material of the human calculi after the uric acid, is in the fame predicament with this acid. I have not yet found it in the calculi of animals, or in the bezoars which I have been able to examine. It would not however be accurate, abfolutely to deny its exiftence in thefe concretions; I have as yet analyfed too few of them, and there are too many fenfible or exterior differences between thefe bezoars

hich I knew only by eye-fight, not to lead ne at leaft to fufpect, the poffibility of the exftence of the oxalate of lime, in fome of thofe oriental bezoars, whofe hardnefs, polifh, and dark colour, feem to approximate to fome fpecimens of thofe hard and brilliant moriform calculi, which I have pretty frequently found in the human bladder. Though it is not eafy to comprehend the formation of this falt in the urinary paffages of man, as the chemifts had hitherto believed it to be foreign to animal matters, and as they had found it only in fome vegetable matters, it is no longer difficult to admit the poffibility or probability of this formation in the bodies of animals.

From thefe confiderations it follows, that the analyfis of the urinary concretions of animals, compared with thofe of man, and extended to the concretions which frequently exift in them as well as in man, in other regions, befides the kidneys and the bladder, becomes of great confequence in the phyfiology of animals, and, that it ought to be ftrongly recommended to thofe who poffefs fuch rare fubjects, fo difficult to be collected by a fingle individual.

SECTION

Section VIII.

Of the Arthritic Concretions of Man.

77. I HAVE ſeveral times pointed out in ſome articles of this ſection, devoted to the analyſis of the animal matters, that medical men, reſting upon numerous obſervations, had found ſtriking affinities between the diſeaſes of the urinary paſſages and the gout. It is eſpecially with the calculi of the human bladder, that this analogy has been very often announced. In fact, we frequently ſee long attacks of the gout, followed by the gravel and the ſtone, and it is not uncommon to find calculous concretions in the kidneys and the bladder of gouty old perſons. Gouty parents have frequently children ſubject to the ſtone, and vice verſâ. Frequently alſo, perſons ſubject to the gravel, experience a ceſſation of this complaint, at the ſame time that their joints are attacked with arthritic pains. After the ancients, Sydenham, Cheyne, I. A. Murray, and ſeveral other celebrated phyſicians of the laſt and the preſent centuries, have confirmed this analogy, which now is univerſally admitted.

78. As

78. As in all thefe cafes, folid concretions, more or lefs prominent, are frequently formed round the articular capfules, and the extremities of the bones, which impede their motion, which frequently even render them entirely immoveable, and which fometimes are of confiderable bulk, fince Severinus has defcribed fome as large as an egg, it was very natural for phyficians to think, that the nature of thefe concretions was the fame with that of the folid bafe of the bones, and we have feen that they had admitted the fame opinion, refpecting the fubftance of the calculi of the bladder, before Scheele had made the valuable difcovery of the uric acid. In fact, the firft experiments made upon the arthritic concretion, had fometimes indicated a refemblance with, and fometimes a difference from the bones and the urinary calculi. Schenkius faid, that the arthritic concretion pulverized, affumed a confiftence with water, like plafter. Pinelli, defcribing in 1728, fome experiments upon the arthritic matter, faid he had obtained from it by diftillation, volatile alkali, and fome drops of oil, as alfo a refidue, weighing $\frac{1}{12}$. He could not diffolve it in the oily ammoniacal liquors, which he employed, though he could in the fulphuric, muriatic, and even acetous acids. Neverthelefs, Doctors Alfton, Whytt, F. Hoffman, and Boerhaave, have recommended the ufe of alkalies and lime-water in the gout, as well as in the ftone. Thefe data, which are contra-

contradictory to the firft refult of Panilli, only produced uncertainty refpecting the gouty matter: Cajetan-Tacconi alfo, after an examination, though a very fuperficial one, of the finovia of gouty patients, and from its effect, of fometimes turning the fyrup of violets green, and fometimes red, has concluded that the gout was either acid or alkaline, and that it arofe from this double caufe. Such a conclufion could only embarrafs ftill more the theory and the practice of the art.

79. After the difcovery of Scheele, refpecting the acid nature of the moft frequent of the urinary calculi, there was reafon to hope for fome more decifive experiments upon the arthritic matter. Yet we find but a few effays upon this important object, in the twenty years which have elapfed fince this period. We read in the memoirs of Stockholm, for 1783, an obfervation of Mr. Roering, from which it refults, that fome concretions expectorated by a gouty old man, were phofphate of lime; but I have already elfewhere remarked, that the pulmonary concretions were formed of this falt, and it is very evident, that thefe calculi muft be independent of the arthritic matter. Mr. Watfon has publifhed, in the medical effays of London, Vol. I, 1784, (medical communications) an examination of the arthritic concretion, taken from the dead body of a gouty perfon, from which he has concluded this matter to be very different from that of the calcu-

lus, fince it diffolved in finovia, and mixed eafily with oil and with water, whilft the calculous fubftance prefented properties entirely the reverfe. But this difference might depend upon the ftate of combination of the calculous fubftance; and this has been difcovered to be the cafe by Mr. Tennant, of London, who announces, that the arthritic concretions are compofed of the acid of the calculus, combined with foda.

80. This fimple notice, inferted in fome periodical works, appeared to me of fo great importance to the progrefs of the art, that I ardently wifhed to confirm it, by a correct experiment. Several years elapfed without my being able to fatisfy my wifh, as it was impoffible for me to procure arthritic concretions, though I had applied to feveral phyficians for them. It was not till towards the month of Vendimiaire, in the year feven, that a favourable opportunity prefented itfelf, for which I am indebted to Citizen Veau, a phyfician of Tours, profeffor at the central fchool in that town, and equally diftinguifhed for his learning and his ardent zeal, for the progrefs of the healing art. This phyfician, who is fully fenfible of the value of correct chemical refearches, applied to the phenomena of the a[illegible]conomy, brought me [illegible]tracted from an [illegible] the great toe of [illegible]en afflicted [illegible]who, to [illegible] judge

judge from the ſwelling of different articulations, ſeemed to carry in this manner, in the whole of his body, more than a kilogramme of this concrete matter.

81. This patient, whoſe feet, hands, and knees are tumefied, experiences no pain in moſt of theſe regions, when the ſkin is touched. Their arthritic concretions are every where adhering to the bones. As to that which is ſituated at the laſt phalanx of the great toe of the left foot, and from which the portion which has been ſent me, proceeds, the tumor is about thirteen centimeters in circumference; it is ulcerated and open at its ſuperior and outer lateral part; it daily diſcharges a fetid pus, which has not been examined, but which appears to carry with it a portion of concrete arthritic matter. For a year paſt, the patient ſuffered excruciating pains; he ſcarcely ſlept a few minutes, without being wakened by the violence of his diſeaſe. For ſeveral months paſt, he had not quitted his bed, and he frequently emitted piercing cries. The part of the podagric concretion, which was tranſmitted to me by Citizen Veau, with the details which I have juſt given after him, had been extracted from this ulcerated tumor, to the opening of which, it had been propelled. I have ſubjected it to the experiments which its ſmall quantity permitted me to try; they were made in the preſence of the enlightened phyſician, to whom I am indebted for it.

82. This

82. This whitiſh, irregular concretion, finely granulated as it were in its texture, much reſembling in appearance, a broken piece of officinal agaric, was about four centimeters in extent; it weighed more than three grammes and a half. It was porous and light; it could not be triturated in a mortar, without difficulty, on account of the abundant membranous pellicles, with which it was interſected; it cut after the manner of tallow, and the parts expoſed by the ſection, were poliſhed and brilliant, like the laminae of ſpermaceti. Heated by a pretty violent trituration, it exhaled a faint animal odour. A gramme of it, heated in a ſilver crucible, exhaled a white, fetid, empyreumatic, and ammoniacal ſmell; it burned without ſoftening, although it ſwelled into bubbles, the crucible, taken from the fire after the ceſſation of the ſmoke, preſented a blackiſh reſiduum, of an alkaline and bitter taſte, analogous to that of an alkaline pruſſiate, weighing a ſixteenth of the maſs employed. Diſtilled water poured upon this reſiduum, diſſolved a part of it, and gave with the ſulphate of iron, a blue precipitate of very fine pruſſiate. It therefore contained a fixed alkali, and a very abundant animal matter.

83. Treated with a hundred times its weight of water, by an ebullition of ſome minutes, it almoſt entirely diſſolved in this liquid, becoming covered with a froth, like that of a ley of ſoap, and exhaling a faint animal odour, ſimilar

lar to that which proceeds from ſkin, membranes, tendons, and ligaments, when boiled in water. There was only about a tenth part of the concretion that was not diſſolved. This part was like ſwelled membranous pellicles. The ſulphuric acid poured into the ſolution, produced in it a white pulverulent precipitate, which in collecting, aſſumed the form of ſmall cryſtalline needles, very diſtinguiſhable for being the uric acid. The ſupernatant liquor, gently evaporated, exhibited cryſtals of ſulphate ſoda, difficult to be obtained from it, well ſeparated on account of the viſcous and gelatinous ſtate, which the evaporation had produced.

84. A portion of the arthritic concretion equal to the two preceding, was treated with more than a hundred times its weight, of a concentrated ley of pot-aſh, aſſiſted by heat. It was almoſt completely diſſolved in it, exhaling the faint animal odour already indicated. The liquor filtred, in order to ſeparate from it ſome undiſſolved flakes, was mixed with weak muriatic acid, which formed in it a white precipitate, ſimilar in its aſpect and all its properties, to the uric acid, and very recognizable for this ſpecies of acid. Immerſed in a very weak ley of pot-aſh, a part of this concretion was ſoftened, and loſt all its conſiſtence, without looſing its form ; uric acid was afterwards precipitated from the liquor, by the addition of muriatic acid. The arthritic concretion

cretion therefore resembled a urinary calculus, formed by the uric acid excepting that the proportion of animal matter in it, appeared to be more considerable than in the latter.

85. These experiments evidently prove, that the arthritic concretion in question, is formed of a mixture of urate of soda, and of gelatinous animal matter: they confirm what Mr. Tennant had announced. They nevertheless indicate, that this salt, which has not yet been found in the urinary calculi, and which contains only the uric acid, combined with the soda, so frequent in the animal liquors, is enveloped or accompanied in it with a mucous substance, which greatly exceeds its own quantity. They shew a relation, which has hitherto been announced in a vague manner, between the gouty humour, and the urinary concretions; they prove that the arthritic concretion is deposited between the laminæ of the articular capsules, and that it is by separating these laminæ, and crystallizing between them with more or less rapidity, that they envelope and swell the articulations; that they produce pains more or less acute, on account of the drawings which they excite in the nerves, and in the lymphatic vessels. Thus the superabundance of the uric acid, its deposition, or its transportation towards the articular organs, the mucous capsules, the meshes of the tendons, appear to be the immediate cause of the gout. Citizen Berthollet has already ascertained, that the

urine

urine of gouty perſons, does not contain phoſphoric acid during the attacks of this diſeaſe: it would alſo be of importance, to inquire whether it be equally deprived of uric acid. This is a new career, which chemiſtry opens to medicine, and of which the latter ſcience will undoubtedly avail itſelf. It will be equally intereſting to determine, why this uric acid is united with ſoda in the arthritic depoſitions, whilſt it has not yet been found under this form of combination in the urine, a ſtate in which, in fact, it cannot exiſt in it, on account of the free phoſphoric acid which it contains.

Article XXVII.

Of the Liquor of the Proſtate Gland, and of the Sperme.

1. THE proſtate, a kind of flat, cordiform gland, ſituated between the moſt elevated part of the urethra and the rectum, to which it is attached by its ſuperior face, of a firm texture internally, compoſed of many follicles preſſed againſt each other, preſents from ten to twelve excretory ducts, which open into the canal of the urethra round the eminence known amongſt anatomiſts, by the name of *Criſta Galli*, or *verumontanum*. This gland,

gland, which is the ſize of a large cheſnut, and which is of a texture ſufficiently denſe to preſent a conſiderable reſiſtance to the cutting inſtrument in the operation of lithotomy, ſecretes a liquid in ſmall quantity, which is poured into the urethra by the apertures that have been indicated, and by the effect of the venereal orgaſm, ſometime before the ſeminal liquid. Its diſcharge, which only takes place by a kind of exudation, and never, or only very rarely by jets, is accompanied with a pleaſurable ſenſation, which eunuchs enjoy inſtead of that which is produced by the ejaculation of the ſemen.

2. A diſcharge of this liquor is occaſioned in ſome men, by the preſſure ariſing from the expulſion of the excrements, or of the urine, and it varies conſiderably in quantity, in different individuals. All that is known reſpecting its properties, reduces itſelf to its whitiſh colour, its thick and viſcous ſtate, its faint animal ſmell, and its ſoft lubricating quality. No chemiſt has yet undertaken to analyze it; ſome have contented themſelves with obſerving, that it was ſuſceptible of being coagulated by alcohol, and they have conſequently believed it to be of an albuminous nature. It may be ſuppoſed to contain, like all the humours of this kind, ſoda, and phoſphates of ſoda and of lime. Perhaps it is alſo charged with a certain quantity of gelatinous matter, as its homogeneous, equal, and as it

were,

were, mucous viſcoſity ſeems to indicate. It appears that its real uſe is to lubricate the canal of the urethra, to facilitate the rapid paſſage of the ſeminal liquor, to unite with this liquor, to augment its volume, and perhaps even to modify its properties, though we are not yet able, exactly to determine the function which it performs in its union with the ſpermatic liquid.

3. The ſeminal liquid, or the ſperm, is ſeparated in the teſticles from the arterior blood, which is conveyed thither by the ſpermatic arteries. The texture of this ſecretory organ, preſents a ſeries of veſſels rolled together like thread upon a ball, which muſt produce a conſiderable retardation of the liquid, with which they are conſtantly filled. From this texture, the ſperm paſſes into the epididymis, a kind of body applied to the upper part of the teſticle, and ſomewhat different from it in texture. It is terminated by a ſolid and denſe canal, which pours the liquid received by it into the two ſeminal veſicles, which are membranous bags, ſituated upon the neck of the bladder, and connected together by a cellular texture. Each of theſe veſicles is contracted into a canal, which opens into the urethra, at the two ſides of the eminence called *verumontanum*, after having traverſed the thickneſs of the proſtata. The ſperm is diſcharged with a very rapid motion, and is ſometimes ejaculated

lated to a pretty confiderable diftance from the penis.

4. The fpermatic liquor, which is not formed in man, and animals until after their growth is completed or far advanced, together with the fuperabundance of nourifhment, which accompanies this circumftance of life, marks its production, by a period well characterized, and by very remarkable appearances. The region of the genital parts and the chin, become covered with hair, the voice changes and becomes hoarfe, the figure becomes determined and modified; the mind of the individual who arrives at this period, acquires more activity and energy; the perfon becomes taciturn, melancholic, and morofe, till he has fatisfied the defire which nature has produced in him. It is well afcertained, not only that the formation of this liquor has a great influence upon the animal economy, but that its too frequent difcharge, as well as its retention in its refervoirs, produce maladies, which are fometimes of a very fevere kind. The firft enervates the phyfical and moral powers, fo as to degrade, and even brutify the individual who commits this imprudent wafte; the fecond produces in the moral and phyfical functions, a derangement, a kind of weight and obftacle, which impedes, and feems to opprefs them. A moderate evacuation proportionate to the defires, fupports the health in that equilibrium which eftablifhes it, and fulfils the intention of nature, who has

provided for the re-production of animated beings, by the fentiment and the want of pleafure.

5. The fpermatic liquor, at the moment when it is evacuated by an individual, of a good conftitution appears to be a mixture of two different fubftances; the one, vifcous, gluey, homogeneous, and whitifh; the other thick, grumous, and opaque, in which many white, and as it were, filky filaments are perceived, efpecially when it is agitated in water. It diffufes a particular faint fmell, which is found alfo in the leaf-buds of the cheftnut, and in the antheræ of many flowers; it is alfo found in bones and ivory when fawed, filed or rubbed; on which account the ancients called thefe parts fpermatic. It has the property of becoming fluid and tranfparent, fome time after it has been evacuated; its mucous nature, the feemingly animated particles, which can be perceived in it by the microfcope; finally, the cryftals which are depofited in it by its expofure to the air, were the only chemical facts collected, refpecting this liquor, previous to the month of April, 1791; and it is known to how many hypothefes and theories more ingenious than true, thofe ideas had given rife. At this period, Citizen Vauquelin publifhed, in the Annales de Chimie, a memoir upon the human fperm, in which he has defcribed an interefting courfe of experiments. As this is the only fkilful inquiry into this matter, with wh

I am

I am acquainted, I shall here give a sufficiently detailed account of it, to suffer none of the new and useful results, which this memoir contains to escape my consideration.

6. The sperm has a slightly acrid and irritating taste, which sensibly constringes the membranes of the mouth. Though its specific weight varies greatly, it is constantly more considerable than that of water, as it is always precipitated to the bottom of this liquid. When the sperm is agitated in a mortar, or upon porphyry, or even between two pieces of paper, it becomes frothy, opaque, thick, and tenacious, like a kind of pomatum. It appears that this phenomenon proceeds from the air, which interposes itself between its particles, and undoubtedly also from the evaporation of a part of its water, which permits an approximation and crystallization of the saline matters, with which this liquid is replete, as we shall soon see. The sperm, as it is discharged from the urethra, turns the syrup of violets green, precipitates the calcareous salts, and the metallic solutions, on account of the fixed alkali which it contains. As its thick and flocky portion loses its caloric, it becomes transparent and more equally consistent than it was before. Some hours after, the sperm becomes more fluid, which does not proceed, as had been believed, from the absorption of atmospheric air, since it diminishes in weight; besides which, this phenomenon takes place in close

9. When the ſperm, reduced to a tenth of i weight, by complete deſiccation in warm ai dry air, is expoſed to the fire in a ſilver cr cible, it is ſoftened by the firſt degrees of hei aſſumes the yellow colour of bread cruſt, ai exhales yellowiſh fumes, which have the ſm of burned horn. At a ſtronger heat the fum becomes thick, the ſperm is turned brow ſwells, and grows black, exhaling a ſtro ſmell of ammonia. Removed from the fir when no more vapour is diſengaged, and whe the ſpermatic matter no longer undergoes an ſenſible change, the crucible contains a prett voluminous coal, which, when lixiviated wit diſtilled water, furniſhes carbonate of ſod amounting to almoſt a fourth of the ſperm tha has been dried. This coal, burned afterward and completely incinerated, gives a white re ſiduum, forming a third of the dry ſperm, an poſſeſſing all the properties of the phoſphate o lime. This kind of analyſis by open fire deſtined, as it is evident, to ſeparate the tw fixed ſubſtances contained in the ſperm convinced Citizen Vauquelin that this liquo contained one hundredth part of its weigh of pure ſoda, and three hundredths of phoſ phate of lime. When we heat the ſperm in a diſtilling apparatus, inſtead of employing an open veſſel, we obtain water, carbonate of am monia, and a ſmall quantity of oil. The coa which remains, does not differ from tha which has juſt been deſcribed. Citizen Vau queli

quelin has not detailed the phenomena and the products of this diftillation, undoubtedly, either becaufe he has performed it only upon too fmall quantities to obtain very fure refults, or becaufe it has furnifhed him with none fufficiently remarkable and fufficiently different from what are obtained from all the animal fubftances in general to merit a particular defcription. With refpect to the action of caloric upon the fperm, as it is evacuated from its ducts, it is only to be obferved, that it accelerates its liquefaction, that it does not coagulate it like many other animal liquids, and that this confequently contains no albuminous matter.

10. The fperm that has not been liquefied by the air, and immediately after it has been ejaculated from the urethra, does not diffolve in cold water; when it is much agitated in this liquid, it divides into flockes in it, and communicates to it a flight opacity. The folution does not fucceed better in boiling water; the thick matter becomes on the contrary more denfe, fhrinks together, and attaches itfelf to the rod which is ufed for agitating it. When the fperm has been expofed to the air and has become fpontaneoufly liquefied, it eafily unites with cold and hot water. Alcohol and oxigenated muriatic acid feparate the fpermatic matter from the water, in the form of white flockes. Pot-afh, foda, and ammonia, render the fperm mifcible with water, but only when they are concentrated. Lime difengages ammonia from it only when

when the ſperm has been for ſome time expoſed to hot and moiſt air, which proves that the ammonia is formed during the decompoſition of this liquid, and even in very large quantity. The acids have alſo a ſolvent action upon the ſperm; even the weakeſt, wines, urine, exert this action in a ſenſible manner; the alkalies however do not ſeparate it from this ſolution, nor in fact do the acids precipitate it from its alkaline ſolutions. The proof that wines and urine diſſolve the ſperm only with the aid of the acid contained in theſe liquors, is, that they no longer produce this effect when they are deprived of this acid by any means whatever. Accordingly, water reduced to the ſlightly acid ſtate, to the ſame ſlight degree of acidity which theſe two liquids poſſeſs, by the addition of a ſmall quantity of ſulphuric acid, diſſolves the ſperm.

11. The oxigenated muriatic acid acts upon the ſeminal liquid in a manner very different from that of the ordinary acids. Inſtead of diſſolving it, it coagulates it into white flockes, inſoluble in water and the other acids. It produces this effect even upon ſperm liquefied by the air. A large quantity of this acid liquid, poured upon the ſperm, gives it a yellow colour, and renders it perfectly ſimilar to the matter which is diſcharged in ſome gonorrhoeas, eſpecially at the termination of this diſeaſe. At the moment when it exerts this action, its ſmell diſappears

which indicates that the ſperm abſorbs the oxigen of the oxigenated muriatic acid, and that the coagulation of the ſperm and its yellow colouration, proceed from this abſorption. This effect is ſimilar to that produced by the ſame agent upon the lachrymal humour, the naſal mucus and the bronchial juice.

Finally, the ſperm does not decompoſe the ſalts of barites and ſtrontian when it is recent, or when it has been kept in a well-cloſed veſſel, or has liquefied ; but it decompoſes them when it has remained for ſome time expoſed to the air and when it has begun to depoſit rhomboidal cryſtals. It is very evident that this decompoſition then proceeds from the ſoda of the ſperm having combined with the carbonic acid of the atmoſphere, and formed a carbonate capable of acting upon the ſalts of barites and of ſtrontian, by a neceſſary double elective attraction.

12. From all theſe facts combined, Citizen Vauquelin concludes that the ſperm poſſeſſes ſome properties in which no other animal matter participates, and eſpecially the following which form its ſpecific characters. It is alkaline; it ſpontaneouſly depoſits phoſphate of lime in cryſtals or irregular grains; it becomes ſour in hot and moiſt air; it is inſoluble in water in its natural ſtate; it diſſolves in it both when it has been liquefied by the air and when it has been dried in it; it is ſoluble in the alkalies and the acids, and they cannot be reciprocally precipitated by each other. By comparing all the reſults of his experiment together,

together, he found in a thousand parts of sperm, the following proportions of its constituent materials:

Animal mucilage	-	60.
Phosphate of lime	-	30.
Soda - -	-	10.
Water - -	-	900.

He observes that the causes of several of the phenomena peculiar to this liquid are yet unknown, especially that of its liquefaction by the air, its insolubility in water, its solubility when it is liquefied, the state and the proportion of the phosphate of lime which it holds in solution, the crystallization of the latter. The mucous animal matter contained in this liquid is not less a kind of singular problem in its nature and properties. It is not albumen, and if it approaches more to the nature of gelatin, it also differs from it by very remarkable characters. It appears that it is the cause of the viscosity, the flocky state, the smell, the insolubility in water, the spontaneous liquefaction, and several other properties of the sperm; but nothing more can be said respecting its singular nature, as it has not yet been possible to insulate it from the other materials of the sperm and to examine it when separated. It would be interesting, for example, to know its alteration by tannin, &c.

Though Citizen Vauquelin's analysis of the sperm is full of curious facts, and even furnishes very new and entirely unexpected results, it must however be admitted, that it does not yet

give us any light refpecting the properties of this humour, almoft miraculous in its effects; and that we do not find in it any poffible application to its fecundating power. In the fame manner we have feen, in one of the preceding articles, that the cerebral medulla or pulp, with which fome phyfiologifts have compared the fpermatic liquor, did not yet prefent in the albuminous nature indicated by its analyfis, any fact capable of elucidating its functions.

ARTICLE XXVIII.

Of fome Animal Matters peculiar to the Mammalia.

1. AFTER having treated, in the preceding articles, of the matters that are common to all animals, which conftitute their bodies in general, and efpecially of thofe which belong to man, the method which I have adopted requires that I fhould fpeak of the fubftances peculiar to each order of animals. But it is not neceffary that I fhould here confider the properties which appertain efpecially to the ufes of each of them; it is only to compare them with thofe that have already been examined, to point out the relations and the differences which fubfift between them, to indicate in a general manner what analogies or diffimilarities there may be in their properties;

properties; finally, to give an exact but concise idea of their nature, that they are here to be considered.

2. Amongst the matters which the mammiferous animals or the viviparous quadrupeds furnish to the arts, there are ten which particularly merit the attention of the chemist, namely: Ivory, the horn of the stag, horn, wool, musk, civet, castor, ambergrease, spermaceti, and the bezoars. It will be seen that I do not here enumerate a multitude of substances, either very well known and generally employed, or formerly considered as very valuable and now fallen into disuse; such as the flesh, the skins, the hairs, the elaws, the fat, the intestines, the different bones, the teeth of several animals, of the hippopotamus, of the castor; the blood of some, that of the wild goat; fossile horns and teeth, the turquoises, the unicorn's horn, the elk's foot, &c. down to the excrements of the dog, formerly called *album greecum*. These last-mentioned matters have been introduced by credulity, ignorance, prejudice and quackery into medicine; but the lights of chemistry have gradually caused them to be rejected from pharmacy. I have selected the ten substances which are the most important by their properties, their multiplied and frequent uses, as well as by their nature. They will besides serve to elucidate the nature of those of which I shall not speak, and to which they are analogous.

A. *Of Ivory.*

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A. *Of Ivory.*

3. Ivory, which is ſo well known and ſo much employed, is an oſſeous ſubſtance of a fine cloſe and homogenous texture, which belongs to the enormous teeth called the tuſks of the elephant. This animal, of which at leaſt two principal ſpecies are known; the *Elephant of India* with a concave forehead, molares marked with ſtripes, tranſverſely undulated, with ſmall ears; and the *Elephant of the Cape*, with a convex forehead, molares marked with tranſverſe lozenges, with very ample ears, and of which the Mammoth of Siberia ſeems to conſtitute a third ſpecies, forms by itſelf a particular order of the mammalia, very well characterized by the abſence of the dentes canini and the inciſores inferiores, by the prolongation of the inciſores ſuperiores into tuſks, by the flexible and ſenſible trunk which terminates its noſtrils, by its extraordinary bulk, by its intelligence and the energy of its paſſions.

4. The ivory of the Cape or African elephant is chiefly preferred, both on account of the conſiderable bulk of the tuſks of this ſpecies, and on account of its hardneſs and beauty. The foſſile teeth which have not loſt their ſolidity are alſo employed. This ſpecies of oſſeous ſubſtance has a texture, a colour, a fineneſs of grain and a hardneſs, which render it very uſeful in a great number

number of the arts. The net work of lozenge: or rhomboidal areolae which is obferved in th transverfe fection of thefe teeth, is a characte by which ivory is eafily recognized, and whicl diftinguifhes it efpecially from common bones, in which we fee only longitudinal ftrata or rays. Ivory, when fawed or filed, exhales a difagreeable faint fmell, much refembling that of the fperm. The beautiful polifh which this fubftance receives, the brilliant whitenefs which diftinguifhes it, the foftnefs of the forms which it receives, the various colours which are communicated to it, and which adhere pretty ftrongly to it, are well known.

5. As to its nature, ivory is compofed, like the bones, of a gelatinous matter and phofphate of lime. In the fire, it becomes black, is converted into coal, and even affords fo black and fo fine a coal, that it is particularly employed in fome of the arts, by the name of *ivory black*. When diftilled, it yields water, a thick oil, and carbonate of ammonia; calcined to whitenefs it leaves pure phofphate of lime. The acids foften it; water, on the contrary, by long ebullition, extracts from it gelatinous matter, and thus forms a tranfparent and very white jelly. The real difference which exifts between ivory and the bones is not yet known: it appears to confift in the different proportion of the two matters which compofe this kind of folid texture. It would be ufeful, in inveftigating this fubject, to examine the difference between the enamel

enamel of the human teeth, and the offeous fubftance properly fo called ; and that which exifts between the teeth of the hippopotamus and the rhinoceros, which are fometimes employed for real ivory, and ivory ftrictly fo called.

Of the Horns of the Deer.

6. WHAT is called in the materia medica and pharmaceutical chemiftry hartfhorn is called the antlers in natural hiftory and the chafe. The deer is a mammiferous and ruminating animal well characterized by its two hoofs its four ftomachs, its offeous horns which it fheds every year, its fmooth hair, its fhort tail, its long and thin legs, its lachrymal duct at the anterior part of the eye, its eight dentes incifores in the lower jaw, their abfence in the upper, as well as the abfence of the dentes canini, and of the gall bladder. The two offeous excrefences or natural exoftofes with which the forehead of the male is provided, have long been much employed under the name of hartfhorn. Thefe horns are round, and bear feveral conical antlers, the number of which varies according to the age of the animal, and ferves to afcertain it. Immediately after they have fprouted out they are foft, provided with a hairy fkin, full of blood-veffels; but they foon harden, are deprived of their fkin, and become compact and offeous.

7. All the experiments which have been made upon the horn of the deer, all the products which

which are extracted from it, all the uſes to which it has been applied, prove that it is a real oſſeous ſubſtance, formed of a gelatinous matter and phoſphate of lime. By boiling the ſhavings of hartſhorn for a long time in water, a conſiderable quantity of light, mild, and inſipid jelly is obtained from it. This jelly is extracted either for the nouriſhment of ſick perſons, or for the preparation of ſeveral medicines, or for that of ſome kinds of food, to which we wiſh to give this form.

When hartſhorn is diſtilled, a reddiſh and ammoniacal water is obtained from it, which was formerly called *volatile ſpirit of hartſhorn*; a thick, brown, and fetid oil; much carbonate of ammonia in a ſolid form, and ſoiled by a little oil; carbonated and oily hidrogen gas and carbonic acid gas. There remains after this diſtillation a coal which retains the form of the matter diſtilled, and which, after its incineration, furniſhes a little carbonate of ſoda, carbonate of lime, and much calcareous phoſphate.

8. As great uſe was formerly made of the different products of diſtilled hartſhorn, each of them was rectified with much care. The ammoniacal water was diſtilled by a mild heat, by which means it was obtained much leſs coloured. This liquid was frequently combined with the ſuccinic acid, in order to prepare the *ſuccinated liquor of hartſhorn*. The brown carbonate of ammonia was digeſted in a ſmall

quantity

quantity of alcohol, and by thus depriving it of the portion of oil which it contained, the *volatile ſalt of hartſhorn* was obtained white. The oil produced in this operation, was purified with the greateſt exactneſs; attempts were made to obtain it white, colourleſs, very volatile, and highly odorous, under the name of *Dippel's animal oil.* Formerly, this was accompliſhed only by ſeveral ſucceſſive diſtillations; ſubſequently they confined themſelves to two or three diſtillations, taking care to introduce the oil to be rectified in the retort, with the aid of a long funnel, to avoid ſoiling its neck; for a ſingle drop of brown oil would have ſufficed to colour a very large quantity of white oil; only the firſt portions of the product were drawn off in this manner. Rouelle, the elder, having remarked, that only the moſt volatile portion of this oil was white, adviſed its diſtillation with water, in order to communicate to it only the temperature neceſſary for the volatilization of this portion. I have already remarked elſewhere, that this oil is very light, and very odorous; that it contains ammonia; that it turns the blue vegetable colours green, and acquires a more or leſs brown colour, by the mere contact of the light.

9. Formerly a particular operation was performed, which was named, *hartſhorn philoſophically prepared.* It conſiſted in ſuſpending the antlers at the top of a capital, placed upon a cucurbit, in which water was boiled for a long

time. The vapour continually penetrating tl offeous matter, gradually carried away from the gelatinous matter, and left the phofpha of lime more or lefs pure; fo that the hart horn became white and friable. This tedioı and faftidious practice has been laid afide uj wards of thirty years; at prefent they conte themfelves with calcining the hartfhorn t whitenefs, thus burning all the animal matte and infulating its calcareous phofphate. A potters' ovens are generally employed for pe forming this calcination, the intenfe heat whi exifts in thefe furnaces, produces an incipie vitrification of the earthy phofphate, and v frequently fee the hartfhorn thus treated the pharmaceutical laboratories, fenfibly a proximating to the ftate of porcelain. Tl phenomenon, joined with all the precedin and that of the foftening which the hartfho experiences, when it is immerfed in aci proves that this matter is perfectly of the fa nature with the bones, and differs from the only by its larger proportion of gelatino matter.

C. *Of Horn.*

10. What is particularly called horn, in th arts, belongs to a fubftance which differs fen fibly from the bones, and from hartfhorn Thefe are plates of various thicknefs, femi tranfparent

tranſparent, proceeding from the hollow and conical horns of the bullock. The hoofs of a great number of the mammalia; the horns of the antelope, the goat, the ram; the claws of the cloven-footed or digitated animals, the prickles of the porcupine and hedge-hog, the beard of the whale, and even the hairs, eſpecially thoſe which are rigid and hard, ſuch as the hair of the head, and ſilk, are all of the ſame texture and chemical nature with horn. What I have ſaid above, art 10. ord. 3, concerning the corneous texture in general, is applicable to what concerns horn properly ſo called; I ſhall here add only a word reſpecting what concerns the latter in particular.

11. The horn of the bullock, combining all the properties of the corneous texture already deſcribed upon a former occaſion, and being compoſed of coloured gelatin, united with a ſmall quantity of phoſphate of lime, is ſuſceptible of being fuſed by a mild fire, yielding much water, ammonia and oil in its analyſis, ſwelling, and leaving a voluminous coal, exhaling a ſtrong and fetid colour when burned, melting to a conſiderable degree in water, diſſolving in the acids, and affording Pruſſic acid when ſtrongly heated with fixed alkalies. Theſe very well characterized properties, place the different uſes which are made of horn, in a clear point of view. It is ſoftened, extended, turned, moulded, rolled, it is ſoldered by its edges, it is made to receive impreſſions, it is melted after

having been pulverifed, in order to form veffels which affume the form of the moulds, into which it has been introduced; it ferves for the preparation of glue, and the extraction of feveral pharmaceutical products; it is employed in the fabrication of Pruffian blue, &c.

D. *Of Wool.*

12. WOOL, a kind of long, foft, curly hair, which covers the fkin of feveral of the ruminating mammiferous animals, but which is particularly cut or fhorn from that of the fheep, is in fuch univerfal ufe, that we fhould think it muft be one of thofe animal fubftances, moft accurately known; however, it is only within a few years, that chemifts have occupied themfelves with examining it. Formerly, they contented themfelves with confidering it as diffufing a difagreeable fmell, when it was burned, and as yielding much oil and carbonate of ammonia, by diftillation. It had been remarked in common life, that it did not inflame without great difficulty, and that it exhaled a very fetid thick fmoke, inftead of taking a bright flame. Finally, it was known that the cauftic alkalies eafily corroded it, and that it quickly received, and forcibly retained the colouring matters that were imprinted upon it, fo that it deferved the firft rank amongft the fubftances to be dyed. The extremely nume-

rous

rous ufes, to which it has been appropriated in a number of arts from time immemorial, had brought all its ufeful properties to light; but chemiftry had confidered it only under its moft general relation with all the animal matters, without afcertaining any thing fpecific, in it.

13. Citizen Berthollet began to occupy himfelf particularly with it in 1784, and 1785. He has fhown that the cauftic alkaline leys diffolve it entirely, and that the acids precipitate it from this folution; in this combination, he has fought the mode of action which the alkalies exert upon animal fubftances, and he has particularly availed himfelf of it, for explaining the very remarkable energy which exifts between thefe two matters. In this manner, he has efpecially accounted for the action of the lapis caufticus, upon the bodies of animals. He has moreover fhown, that the coal of wool was difficult to be burned, like that of all the other animal compounds; that wool, treated by the nitric acid, afforded azotic gas, and oxalic acid, with a fatty matter.

Citizen Chaptal, applying this folution of wool in the alkalies, to the proceffes of the manufacture of cloth, has reprefented it as a foap of great utility, for thefe manufactures, and very well adapted for being fubftituted inftead of that which is fabricated with vegetable oil. Wool has, moreover, been confidered as a very bad conductor of caloric, and upon this principle

ciple it has been explained, how, by retaining that which exhales from our bodies, it forms the warmeſt clothing, the beſt adapted for moderating the ſeverity of the winters.

14. To theſe firſt facts, the immediate reſult of the views opened by the progreſs of modern chemiſtry, I muſt add the additional obſervations, which I have made on the nature of wool. The complete inactivity of water upon it, even when kept for a long time boiling in contact with it; the kind of unalterability which it enjoys, when it is kept in a dry and airy ſituation; the fuſion which it experiences when it is heated; the large quantity of thick oil which it furniſhes in diſtillation; the light action which the acids exert upon it; the lively impreſſion which it receives from the alkalies; the conſiderable proportion of fatty matter which it yields, when it is treated with the nitric acid; the ſtrong adheſion which it contracts with the colouring matters, have led me to conſider it as a highly hidrogenated, ſemi-oleaginous matter; the exudation which impregnates it upon the body of the ſheep, and from which it is freed only by ſaponaceous, or ſomewhat alkaline waſhings, is alſo a proof of it. In all caſes, in which art ſucceeds in ſeparating the azote from it, it is quickly reduced to the oily ſtate. Thus, when the nitric acid turns it yellow, and diſengages this principle from it, in the form of gas, a great quantity of fat oil ſwims at its ſurface, whilſt the reſt of the ſubſtance

passes into the state of carbonic acid. Thus, when it is treated with the fixed caustic alkalies, in concentrated leys, and especially with the aid of heat, there is disengaged from it, ammonia formed by the union of its azote, with a small quantity of hidrogen, and what remains united with the alkalies, is an oily body, constituting with them a saponaceous compound.

15. These opinions, drawn from the latest discoveries of the science, explain all the phenomena, and all the properties which wool presents, in the frequent and advantageous uses, to which it is constantly applied. The warmth which it affords, as clothing or covering, its impenetrability by water, its fine colouration, the durability and solidity of its dyes, its destruction by the alkalies, the facility with which grease, and oils penetrate it, the extension of the spots which are formed upon it, even the use which it has, and the functions which it performs upon the bodies of those animals, which are covered with it, and from which we take it in order to clothe ourselves; the adherent and fetid oil, the exudation with which it is impregnated upon the bodies of sheep; the manner in which it defends them against the rain and the water, which are so hurtful to them: its slow combustion; the yellowness and loss of tenacity that are produced in it by long exposure to the air, by gradually absorbing its oxigen, and losing a part of its hidrogen;

hidrogen: in a word, all that appertains to its characters, its formation, its use, its so various properties, its destruction, becomes clear and easily conceivable by the distinct determination of its nature, and of its composition.

E. *Of Musk.*

16. Musk, a substance pretty generally known by its strong smell, and its great use in perfumes, is a sort of resin, or extracto-resinous matter, that comes from a species of ruminating mammiferous animal, named by Linnæus, *moschus moschiferus*, and *chevrotin* in the French nomenclature of natural history. This animal, shaped like the roe buck, having long canine teeth projecting from the mouth in the upper jaw, and a brown fur, with whitish, or fawn-coloured spots, has a bag situated towards the navel, in which the musk is inclosed. It is a native of Thibet and Great Tartary: it is hunted for the sake of obtaining its perfume, which is sold with the bag which contains it. This matter is very rarely met with pure, and without addition or adulteration in commerce. As its smell is extremely strong, and as it is sufficient that there remain a small quantity of the matter of the musk for it to be very marked, resins mixed with different kinds of grease are added to it, on which account it is very difficult to ascertain

aſcertain its real characters or chemical properties.

17. Puré muſk is in dry grumous clots, greaſy to the touch, of a brown colour, of a bitter and ſomewhat acrid taſte, of a very ſtrong ſmell, much reſembling that of fragments of dried coagulated blood. That of Thibet is preferred to the muſk which is ſometimes collected in Ruſſia and Siberia; it is alſo much dearer. Cartheuſer ſays, that this concrete body is compoſed of very attenuated, moveable, oily, volatile and odorous particles, attached in ſome degree to a fixed gummo-reſinous ſubſtance. The ſingular ſubtility of this odorous matter, is known from ſeveral phyſical experiments. A ſingle decigramme of muſk, diffuſes a ſtrong and tenacious ſmell, through a large ſpace, during ſeveral years, and can impregnate ſtrongly five hectogrammes, or two thouſand times its weight of an inodorous powder. Water and alcohol are equally flavoured by this odorous body. Though the whole of the muſk is inflammable, and ſeems to be of a reſinous nature, it appears that the gummy or extractive matter is ſuperabundant in it, ſince Neuman extracted nearly a third of it by water, and only a ſixtieth part by alcohol; it appears alſo, that muſk contains ammonia, or is very much diſpoſed to furniſh it, for when it is treated with pot-aſh, a very ſenſible vapour exhales from it.

18. Though the analyſis of muſk is far from accurate, yet it is evident from the facts al-

[illegible] that this matter is a resinous [illegible] a very volatile, and very [illegible] with an extractive substance [illegible] quantity of saline matter. [illegible] to account for its [illegible] its exalted quality, its [illegible] It is ranked [illegible] cordial, heating [illegible] frequently given, either [illegible] substances, possessing [illegible] properties. It is sometimes [illegible] alcohol. Its great use is [illegible] perfumes: it is mixed with [illegible] many other odorous [illegible] in balsamic, unguents [illegible] pulverulent compositions [illegible] greatly varied. It [illegible] ingredients in the [illegible]

[illegible]

[illegible] very analogous to [illegible] two small species [illegible] quadrupeds, which [illegible] of which is called [illegible] animals, bordering [illegible] are characterized [illegible] latter, four or five [illegible] tongue, semi[illegible] intestines, a [illegible] a bag under the [illegible] contains the unguentaceous matter,

called

lled *civet.* Of these two animals, the one is e civet, properly called *viverra civeta,* havga grey fur, spotted with brown, a tail of an iiform colour, and being a native of Africa: ie other, which inhabits Arabia and the Ines, has an ash-coloured body, streaked with ack, and a tail marked with rings of these lo colours. However, the civet proceeding om the latter species, is preferred to that of ie former.

20. Well chosen civet is a thick substance, ke an ointment, of a pale yellow colour, of ie consistence of honey or butter, of a somehat acrid taste, and of a very aromatic odour; ss agreeble however, than that of musk, iough sensibly analogous to it. It is said, that his humour distends the vesicles situated near he anus, irritating the animal, which rubs self against trees and stones, and thus leaves ome upon them, which is carefully separated; ut it is more probable that it is collected from he bags themselves, with a spoon, after the nimal has been kept inclosed, and after it has een tamed to a certain degree. It is to be renarked, that this humour, when recent, is vhitish, and that when it is kept, it grows yellow and brown at the end of some time. In comparing civet with musk, both with respect to its properties and its nature, the authors on materia medica, and natural history, have remarked, that the first excites more disgust, and even nausea: besides its use, which has long been

been laid aside in medicine, is much less frequent in perfumery, than that of musk. This proceeds in a great measure from the scarcity of this odorous substance, and the excessive price which it bears.

G. *Of Castoreum.*

21. CASTOREUM is an odorous, extracto-resinous animal matter, analogous to musk and civet. It is found in two membranous bags, situated in the groins of the castor, a species of gnawing mammiferous animal, with elongated incisores, without canine teeth, and well characterized by its flat tail, covered with scales, after the manner of fishes. This animal, which inhabits the banks of great solitary rivers in Poland, Russia, Siberia, Canada, New England, and which formerly existed in France, upon the borders of the Rhone, and in Germany upon those of the Rhine, has been especially mentioned, on account of the industry with which it constructs a kind of buildings of several stories, above the water, with double openings for labouring in society with its species, and for its winter-magazines: their construction is with stakes and mortar.

22. Castoreum, recently extracted from the animal, has the consistence of honey, an acrid, bitter, and nauseous taste, and a strong smell, which it loses by desiccation. It becomes

resinous

inous by expoſure to the air. When diſtilled ſh with water, it furniſhes volatile oil, and : water that is vaporized, carries along with almoſt all its ſmell, with the oil which it ſolves. Alcohol, diſtilled inſtead of water, rdly acquires any ſmell, which proves the tle volatility and tenuity of its odorous oil. hen both of theſe liquids are ſucceſſively em-yed as ſolvents, the firſt takes up a ſort of ;h coloured and odorous reſin, the ſecond, gelatinous animal mucilage: when the aque-s ſolution, which becomes turbid, and co-red with oil, by cooling, is ſlowly evapo-ed, ſaline cryſtals are obtained from it. The oholic ſolution gives a red, brown, and ex-ѐto-reſinous reſidue; ether furniſhes one more inous, and more inflammable. When either theſe two laſt-mentioned ſolutions is mixed th water, a precipitate is formed, which, it collects together, aſſumes a ſoft unctuous nſiſtence, without becoming brittle by deſic-ion, which is liquefied by heat, and which ords a volatile and odorous oil by diſtillation. is oily, concreſcible matter, greatly reſembles it which exiſts in the bile, when it is ſepa-ed by the acids. It is almoſt uſeleſs to ob-ve, that the entire caſtoreum gives, by diſ-ation in the retort, the ſame products as all : animal ſubſtances.

23. Though the analyſis of this matter is ry far from having the accuracy that were to wiſhed, and though we can hardly hope to arrive

arrive at this accuracy, on account of the un certainty which almoſt always exiſts reſpectir the purity of the caſtoreum, and of the mi: ture of reſins, gum-reſins, and fats, which a added to, or ſubſtituted for it, in order to adu terate it; what Neumann, Cartheuſer, Ci zens Thouvenel and Bouillon La Grange ha done reſpecting the caſtoreum, authorizes to conſider this matter as a mixture of a reſi a ſort of adipocirous body, a volatile oil, extractive colouring matter, a gelatinous ſu ſtance, and a ſalt. We muſt diſtinguiſh fr it, the more greaſy and oily juice which found in the two ſmall acceſſory bags, that a placed on the outſide of the two large bag filled with the true caſtoreum: there is reaſ to believe, that the gelatin which is extract from this by boiling, proceeds from the mem branous laminæ, which, form the parench matous and follicular texture of the ſides these bags.

24. Caſtoreum is employed only in med cine. Though the diſagreeable taſte, the di guſting ſmell, and the nauſeous property this ſubſtance, frequently render its introdu tion, and firſt retention in the ſtomach, diff cult; phyſicians have diſcovered very importan and very uſeful virtues in this medicine. is eminently antiſpaſmodic; it is very uſef in flatulent, hyſteric, hypochondriacal affe tions; it is alſo found to have a ſtimulant powe It is ſucceſsfully combined with opium, whic diminiſh

diminiſhes its irritating property. The experiments of Citizen Thouvenel, ſhow, that it may be adminiſtered in much ſtronger doſes, than had been done before him. Leſs energetic than muſk, it is preferable to it in a great number of caſes. It is rarely given alone, and in the dry form: moſt frequently it is preſcribed in its ſolutions in alcohol, and ether which are called tincture of caſtoreum. It is an ingredient, in a great number of officinal preparations.

H. *Of Ambergreaſe.*

25. Ambergreaſe is a concrete, oily, and very odorous ſubſtance, of a ſoft and tenacious conſiſtence, like wax, ſuſceptible of being ſoftened by the heat of the fingers, of a grey colour, ſometimes reddiſh or browniſh, marked with yellow or black ſpots, the ſmell of which becomes much ſtronger, and more pleaſant, when it is heated or rubbed. It is in irregular maſſes of very various forms, moſt frequently roundiſh, compoſed of different layers of various thickneſs, frequently united and agglutinated together in ſuch a manner, as to have conſiderable bulk. Pieces are met with that weigh a hundred myriagrammes. Ambergreaſe has manifeſtly been liquid, ſince different marine productions are found immerſed, and enveloped in it. It is ſeen moſt frequently floating upon the ſea water,

near the Moluccas, Madagafcar, Sumatra, upon the coafts of Coromandel, of Brazil, upon thofe of Africa, of China, and of Japan. When it is broken, it is feen to be formed of fpecies of fcales, which detach themfelves. It is infipid; when it is very pure, it fufes without prefenting bubbles or fcum, on being heated in a filver fpoon, over the flame of a taper: it fwims upon water; it does not adhere to the needles of red-hot iron, with which it is punctured, and which pafs through it by melting it. That which does not poffefs thofe properties, is not pure, and frequently contains extraneous refinous bodies, with which it had been mixed.

26. Naturalifts, in comparing the different fpecies of ambergreafe with each other, have diftinguifhed feveral varieties of this fubftance. Wallerius has difcovered and characterized the fix following:

a. Ambergreafe fpotted with yellow.

b. Ambergreafe fpotted with black.

Thefe two firft varieties are the moft valuable, and moft in requeft.

c. White amber of a fingle colour.

d. Yellow amber of a fingle colour.

e. Brown amber of a fingle colour.

f. Black amber of a fingle colour.

However, all thefe varieties proceed from the admixture of fome extraneous fubftances. They might be greatly multiplied, if regard were had to the different foreign fubftances which are found inclofed in the ambergreafe; but

ut it is of no utility to make fuch diftinctions, ; indicate nothing regular and conftant in ie fubftance which they reprefent.

27. Mineralogifts and naturalifts in general, ive held many different opinions refpecting ie origin of ambergreafe. Moft of them have garded it as a bitumen, as a mineral oil, a petroleum that has flowed from the rocks, id been thickened by the rays of the fun, and ie long contact of the falt water.

Several have thought it proceeded from the crements of birds that feed upon odoriferous :rbs.

Some have confidered it as a fcum dif-iarged by the fea-calves; others as crocodile's crements.

Pomet and Lemery thought it was formed by mixture of wax and of honey, baked by the in, and changed by the water of the fea. For-ey, of the academy of Berlin, who adopted iis opinion, endeavoured to confirm it by po-tive experiment. He put a mixture of wax id honey to digeft in the fun, and he fays, iat he obtained from it, a product of a very greeable fmell, and very analogous to that of nber.

Some Englifh authors have confidered amber-reafe as an animal juice, depofited in bags fitu-ted near the origin of the genital organ of the iale whale; fome alfo have thought that iis juice was formed in the urinary bladder of iis cetaceous animal.

 Finally,

Finally, Dr. Swediaur, after an attentiv inſpection of a great many ſpecimens of amber, and according to the reports of ſevera travellers and whale-fiſhers, who have aſſure him, that this product was frequently founc amongſt the excrements of the *phyſeter macrocephalus* or in the inteſtines of this animal, has proved, that the amber is formed in the alimentary canal of this cetaceous fiſh, which alſo furniſhes this ſpermacceti. His opinion is founded, 1ſt, Upon the circumſtance, that the fiſhermen often find amber inthis fiſh; 2d, Becauſe this juice is common in the ſeas which it inhabits; 3d, Becauſe the cuttle-fiſh, *ſepia octopus*, upon which it feeds, inhabits the ſame places; 4th, Becauſe the black ſpots which are ſo frequently found in the amber, are only the beaks of this animal, the moſt common of the bodies that are found incloſed in this concretion; 5th, Finally, becauſe the excrements of ſeveral of the mammalia, eſpecially thoſe of the bullock, the hog, &c. frequently exhale a ſmell analogous to that of ambergreaſe, when they are kept for ſome time. Thus, the reſult of the reſearches of Dr. Swediaur, agrees with the opinion of the Japaneſe, and of Kæmpfer, who regard amber as the excrement of the whale.

28. Ambergreaſe, whilſt it correſponds with a reſinous matter, affords alſo ſome products analogous to thoſe of the bitumens, on which account Geoffroy, Neumann, Grim, and

nd Brow have ranked it among these bodies; hey say they have actually extracted from it, n acid liquor, a concrete acid salt, oil, and a oaly residuum: but these products are not sufficient to decide the nature of a bituminous body, for they belong to many other substances besides the bitumens. Ambergrease is in great part soluble in alcohol, and in ether. This solution is precipitated by water, like that of the resins; this property is different from the almost absolute insolubility of the bitumens in these liquids. Hitherto, neither the action of the acids, nor that of the alkalics upon ambergrease, has been examined; and, in general, it is one of the substances with which the chemists have hitherto least occupied themselves, though it would be of considerable utility if they would undertake an exact analysis of it. It would be useful to know, what species of acid is obtained from its distillation, if it does not contain a concrete oily matter, analogous to that which exists in the bile, &c.

29. Ambergrease is considered in medicine, as a stomachic cordial, and antispasmodic remedy. Most astonishing effects are mentioned to have been produced by this substance, in the most dreadful convulsive diseases, such as the tetanus, and hydrophobia. It is especially reckoned amongst the most powerful aphrodisiacs. It is given in substance, or in the alcoholic tincture. Some individuals are so sensible to its effect, that they cannot support its

action, nor even its ſmell. It is much employed in perfumes, of which it is one of the moſt frequent, and moſt abundant baſes. It is almoſt always mixed with muſk, which it has the property of attenuating and ſoftening, at the ſame time rendering its ſmell more pleaſant and agreeable than it naturally is. It is known that very little of it is required for perfuming large ſurfaces, and for a very long time, and that it is one of the ſubſtances which philoſophers have uſed, for proving the diviſibility of matter, though in this reſpect, it is greatly inferior to muſk.

I. *Of Spermaceti.*

30. The name of ſpermaceti, (Fr. Blanc de baleine) is given to a concrete, white, brilliant, and oily ſubſtance, which is extracted from the head of the fiſh, named by Linnæus, *phyſeter macrocephalus*, the ſame which furniſhes the ambergreaſe. This cetaceous fiſh, which is well characterized by its large head, its ſtraight and pointed teeth, a tuberoſity in place of the dorſal fin, its length of twenty metres, of which the head alone amounts to half, has the upper part of the cranium covered with a cartilage inſtead of bone, and contains, in cavities ſeparate from that of the brain, which is extremely ſmall, the particular ſubſtance of which I ſpeak. It is therefore, neither the ſperm of the

the whale, not the cerebral medullary matter, as many authors had advanced. It is an oil which furrounds the pulp of the brain of this animal, which particularly inhabits the feas of warm climates.

31. When the fpermaceti has been extracted from the head of the fifh, it is found to be mixed with a certain quantity of oil, which is feparated from it, by means of the prefs. It feems that the fame matter is held in folution in the oily fat of all the cetœ in general; for the oil which is obtained from thefe animals, and which the whale-fifhers introduce into commerce, under the general name of fifh-oil, conftantly depofits in the veffels in which it is kept, a more or lefs confiderable quantity of this concrete matter; and in this manner it is extracted from it, in the places in which thefe oils are purified, by merely remaining in refervoirs. It alfo appears, that this matter is one of the moft general products of the bodies of the marine animals, fince the oil which is extracted from the liver, and from feveral other parts of fome fpecies of fifh, equally gives, by mere repofe, the fame fubftance, which is feparated from it by a real cryftallization. We fhall foon fee that this production is in fact one of the moft conftant phenomena of animal matters in general.

32. Spermaceti, purified by repeated fufion, cryftallization, and preffure, is cryftallized in white, brilliant, filver-like plates; it has a peculiar

culiar faint ſmell, which ought not to be confounded with its rancidity. It eaſily cruſhes between the fingers, into a white, lamellated greaſy, and unctuous powder, which is brilliant, like the lamellæ of ſteatites. It fuſes more quickly, and at a lower temperature than wax, but a little leſs eaſily than common fat. When it is thrown upon ignited coals, it inflames, and burns in an uniform manner, without crackling, and without emitting a bad ſmell; its flame is very clear and bright: accordingly candles are made of it, which are preferred to all others, in the countries where this matter is common. Melted ſpermaceti does not ſtain the ſtuffs, upon which it drops it is eaſily detached from them by mere friction, and ſeparates in the ſtate of powder.

33. When ſpermaceti is diſtilled in the retort it is not decompoſed without much difficulty; when it is fuſed and boiling, it paſſes almoſt entire, and without alteration, into the recipient; it yields neither water nor ſebacic acid; its products have not the ſtrong ſmell of thoſe from fats. However, the nature of a part of this fatty ſubſtance, becomes changed, as it is in the ſtate of liquid oil; and if it be diſtilled ſeveral times, ſucceſſively, we at length obtain it completely oily, liquid, and inconcreſcible. Notwithſtanding the apparent alteration which it undergoes in theſe repeated diſtillations, the ſpermaceti does not acquire more volatility than it had before; and according to Citizen Thouvenel,

Thouvenel, the fame degree of heat is required for volatilizing it, as in the firft operation. The oil alfo into which it is converted, has not the lively and penetrating fmell of thofe which are extracted from the other animal matters, treated in the fame manner. The diftillation of fpermaceti with boiling water, according to the fame chemift, prefents nothing remarkable; the water of this kind of decoction is a little curdled; filtred and evaporated; it leaves a fmall quantity of mucous and bitter matter as a refiduum. Spermaçeti fubjected to ebullition in water, becomes more folid, and more foluble in alcohol, than it is in its natural ftate.

34. Expofed to the air, fpermaceti becomes yellow, and fenfibly rancid; though its rancidity is more flow, than that of the fats, properly fo called, and though its fmell is then lefs fenfible than in the latter, on account of that which it has in its frefh ftate; this phenomenon is, however, fufficiently difcoverable in it, to have induced phyficians to obferve, that its ufe ought then to be rejected. It combines with phofphorus and fulphur, by fufion; it does not act upon the metallic fubftances.

The nitric and muriatic acids, have no action upon it. The concentrated fulphuric acid diffolves it, and modifies its colour, and water feparates it from this folution, as it precipitates camphor from the nitric acid; the fulphuric acid difcolours and bleaches it; the oxigenated muriatic acid turns it yellow, and

does

disgust which this medicine inspires, might have had an influence upon the production of the effect which he indicates. Several persons also, to whom he administered it in a strong dose, were attacked with weight at the stomach, and vomiting, though he took the precaution of mixing the spermaceti melted in oil, with yolk of egg and syrup, thus reducing it to the state of a kind of cream. He never found this body again amongst the excrements, which proves that it was absorbed by the lacteals, and actually digested.

37. I must remark, with respect to spermaceti, that having found an analogous substance in the biliary calculi; in the bilious excrements of several patients; in the parenchyma of the liver, dried for a long time in the air; in muscles putrefied in the midst of water, and humid earth; in brain that had been kept immersed in alcohol; and in several other circumstances, which I have mentioned elsewhere, I concluded that this matter, much more frequent, and much more abundant in the animal compounds that had been foreseen, or even suspected, was one of the most constant, and even the most common products of the alteration of these compounds; that it consequently deserved to fix the attention of anatomists, physicians, physiologists, and chemists; that it was necessary to characterize it, by a name proper for distinguishing it from all other analogous substances. It is with this intention, that I have proposed to

name it *adipocire*, as it feems to hold an intermediate place between wax and fat, without being either the one or the other. Its formation and feparation, are of confiderable confequence in the animal economy, whether we view it as a natural production in the cetœ, or as the product of a morbid or feptic alteration in man, and the other animals.

K. *Of the Bezoars.*

38 THE bezoars are calculous concretions, found in the inteftines of feveral quadrupeds. There is fcarcely any of them that is exempt from this kind of malady. Horfes are very fubject to them, and their inteftinal concretions are frequently of extraordinary bulk; feveral of them are fometimes found, which have been worn by friction, and which prefent triangular faces. They are met with even in the wildeft animals, and enormous bezoars of the elephant, the rhinoceros, and the hippopotamus, are kept in valuable cabinets. Formerly, the bezoars of the porcupine were much valued: we fee fome of them fufpended in fpheres of filver wire, amongft the collections of materia medica.

39. Though the oriental and occidental bezoars, have been diftinguifhed from each other, and though a much greater value has been attached to the firft than to the fecond; though finally,

finally, even this diſtinction has proved, that ſeveral ſpecies of bezoars were admitted; the moſt frequent, and the moſt employed, were thoſe that were found in the inteſtines of a ſpecies of goat, which inhabits the mountains of Aſia. This animal *capra ægagrus* of Linnæus, which appears to be the principal ſtock of the domeſtic goat, and of that of Angora, is well characterized by its rough hair, its ſhort black tail, and its large knotty horns. But I muſt apprize the reader, that notwithſtanding the opinion of all the authors of materia medica, who have eſpecially recommended this bezoar, ſeveral ſpecies of bezoar have almoſt always been employed indiſcriminately, at the period when the art attributed great virtues to this animal concretion.

40. We have no exact analyſis of the oriental bezoars; but if we may truſt to an analogy which every thing announces to be correct, it appears, that theſe inteſtinal concretions, all of which have for their baſe or their nucleus, ſome vegetable matters that have been detained in the inteſtines, are conſtantly formed of ammoniaco-magneſian phoſphate, more or leſs pure, or mixed with extract and colouring vegetable matter. It is this laſt foreign matter, which gives to the bezoars their varied green colour, their ſpots of different caſts, their ſtrong or aromatic odour when they are rubbed, when they are pulverized, or when they are heated. Thoſe of the bezoars, eſpecially of the occidental

occidental kind, which I have found to be formed of phoſphate of lime, appear to have belonged to the calculi of the bladder. Daubenton has remarked, that the brown or gold-coloured covering, which is found upon the molares of the ruminant animals, is of the ſame nature with the bezoars that are formed in their inteſtines; and it may be believed that the matter which conſtitutes theſe depoſitions, is diſſolved in the digeſtive juices.

41. We ought not to confound with the natural bezoars, thoſe artificial ones, which are fabricated by mixing earths with a ſmall quantity of glue, and impregnating them with ambergreaſe, muſk, or civet. The exaggerated ideas which formerly prevailed reſpecting the virtues of theſe concretions, had induced ſome druggiſt to imitate them by art. They are eaſily diſtinguiſhed from the true bezoars, by their not being formed of regular concentric ſtrata, as theſe are; by their ſtrata not containing the lamellated, or alculeated, or ſpathoſe cryſtals, which conſtitute the ſtrata of the natural bezoars; and finally, by their chemical nature being entirely different.

Article XXIX.

Of some Matters peculiar to Birds.

1. THOUGH the birds form a very numerous clafs of animals, they furnifh but few peculiar matters to the arts and to medicine, if we except the very numerous fpecies, which ferve for food in the different places which they inhabit or pafs through, and the ornaments which almoft all nations make of their feathers. Under thefe two relations, they prefent only the two following remarks that are of importance for chemical confideration. The difference of the tafte and fmell of their flefh, according to the parts of the globe which they inhabit, and the kind of nourifhment which they take; and the flavour of the mufcles of their wings, and the upper part of the trunk, compared with that of the mufcles of the legs: the fecond muft relate to the beauty and the variety of their plumage.

2. It is known, that the birds of prey are in general hard, and coriaceous, that the aquatic birds are fat and oily, that the gallinaceous are the mildeft and moft nourifhing; that in the clafs of animals, as in that of the mammalia, two kinds of flefh are diftinguifhed; the one black,

black, very ſapid, a little acrid, and perfumed, which exiſts principally in thoſe birds that have the moſt rapid flight, and which frequently change their place; the other white, mild, and inſipid, which is generally met with in the gallinaceous tribe; that this difference depends alſo upon that of the aliments, which the birds uſe; thoſe with black fleſh, called black game, living upon inſects oraromatic ſeeds; thoſe with white fleſh, living upon mild and cereal ſeeds; that the deſired flavour and quality may be communicated to their fleſh, by ſelected aliments; that an influence is produced upon the abundance of fat, and even upon the conſiſtence and taſte of the viſcera, eſpecially of the liver, by the kind of nouriſhment which is given them; finally, that there is a very remarkable difference in many birds, between the muſcles of the legs, and thoſe of the wings; the firſt are of a red or brown colour, and of a particular taſte, thoſe of the wings are white, and yield little nouriſhment. It appears, that the reſpiratory organ, extended into the bones of the wings, and the paſſage of the air into the ſuperior parts, are the true cauſes of this difference between the muſcles of the upper, and thoſe of the lower part of theſe animals.

3. The feathers coloured with the richeſt hues, and forming one of the moſt beautiful ornaments of animated nature, are, to the chemiſt and naturaliſt, among problems, the moſt difficult to be underſtood. It is not only in the

the origin of thefe colours, fo multiplied and diverfified the caufe of their variation, exifting even in the continuity of the fame feathers, that the difficulty of this problem confifts. It exifts with ftill greater force in the difference of the colours, which follows that of the fexes, and efpecially in that which depends upon the age of the birds, the regions which they inhabit, and even the feafons which caufe them to vary. How many errors have not arifen in the diftinction of the fpecies, from thefe variations in the plumage, dependent upon fex, age, climate, and feafon? Who fhall tell what the matter is, which diffufes the rubies, the emeralds, the topazes, and the fapphires, or that which fhines with the luftre of thefe precious ftones, and of ftreaks of gold, upon the covering of birds? At what period will chemiftry be fufficiently advanced, to be able to determine with precifion, the colouring matter, and its formation.

4. Hoping that thefe important queftions may be fuccefsfully difcuffed in more happy times, let us at prefent treat upon fuch of the matters formed by the birds, as are the moft generally employed, and confequently deferve more particularly to fix our attention. We fhall not rank amongft thefe matters, either what are called *halcyon-nefts*, a dry and gelatinous matter, which ferves for the conftruction of the neft of a kind of fwallow, and which they ufe as an aliment in the Levant, after having boiled it in water, and feafoned it with different

different aromatic ſubſtances, or the duck's beaks which are employed in China for the preparation of a glue deſtined for covering paintings upon paper, or the *fats* of different birds to which particular virtues were attributed, or the *down of the ſwan*, conſidered as as ſpecific in cancerous pains and tumours, or the *feathers of the partridge*, &c. which were preferred for burning under the noſtrils of nervous and hyſteric women, &c I reckon only four ſubſtances which deſerve to occupy us in particular, either on account of ſome very remarkable property, or of the great importance of their uſes; theſe are the eggs, the feathers, the dung, and the membrane of the ſtomach.

A. Of Eggs.

5. THOUGH the eggs of all birds have a very ſtrong reſemblance with each other in their general ſtructure and compoſition; though they may all be employed for analogous uſes, the eggs of the hen are eſpecially the ſubject of conſideration as it is from this bird, which is eaſy to be reared, fed, and multiplied, that the eggs are moſt frequently taken for all the uſes to which they are applied. The egg of the hen is compoſed of white, yolk, ligaments, which are called glaire, of the chick, of a thin interior membrane, and of a ſolid ſhell placed outwardly and ſerving as a cover to all the parts of which the egg is conſtituted.

6. The white of the egg, *albumen* liquid, vifcous and gluey matter, whi rounds the yolk, and forms two very layers about it. Though the vifcofity liquid proceeds from its peculiar nature, i owing to a light filamentous and vafcul ment, which traverfes it in all parts, anc it in a very tranfparent kind of veficle white has an infipid tafte; it thickens, l white, opaque and folid by boiling; i into a yellow, tranfparent, brittle, ar ciniform matter by a gentle, long co heat. This coagulation, this folidificat fire, conftitute the moft marked characte white of the egg, and it is on accoun exiftence in feveral liquid animal matte as the ferum of the blood, &c. that th been called albuminous liquors. The egg when frefh turns the blue vegetable green, it hardens in hot and dry air into parent ftratum that is frequently emplo varnifh upon pictures; by expofure air, it abforbs a greater quantity of than it contained, and acquires the dif to be more fpeedily and more ftrongly h by fire; it diffolves eafily in water, wi exception of fome flakes which fwim diffolving, in cafe the white of egg is oxigenated. The acids coagulate this the alkalies re-diffolve it in part; the folutions render it turbid, and precipita well as lime-water. The oxides of the

caufe it to coagulate. We find in it, by an exact analyfis, muriate of foda, phofphate of lime, and very a fmall portion of fulphur, which is difengaged from it during coction in the ftate of fulphurated hidrogen gas.

7. The yolk of the egg, *vitellus ovi*, is alfo a fpecies of albuminous matter, foluble in cold water, coagulable by heat and by the acids, which befides contains a colouring fubftance hitherto little known, and which perhaps may be iron, and a certain quantity of mild oil which is feen to exude from the yolk when it is hardened and heated, and which is extracted by the prefs: this oil of egg is prepared in pharmacy, and employed in medicine as a topical, emollient, and relaxant remedy. Its prefence in the yolk eftablifhes a remarkable analogy between the feeds of vegetables and eggs. It is the caufe of the emulfive form which the yolk of egg affumes when it is beat up with water, or the animal emulfion called (*lait de poule.*)

8. The ligaments or *chalazæ*, which are called glaire, and which fufpend the interior parts of the egg, are a kind of albuminous cord more folid than the white, nearer at leaft to the concrete ftate, and confequently believed to be more oxigenated. The chick is placed upon the yolk, and always prefents itfelf oppofite to the hole which is made in the fhell, in whatever manner we may place the egg, fince it is

 fituated

ſituated upon the thinneſt part of the yolk traverſed by the ligament, round which the yolk turns as upon an axis; it contains the rudiment of the body of the bird, which requires only to receive movement by incubation, and which is developed by the effect of this movement; the chemical nature of the chick is not known, nor has it even been poſſible to analyſe it in particular.

9. The interior membrane of the egg, which envelopes the white and the yolk, and which is glued to the interior ſurface of the ſhell, is, like all the other animal membranes, a gelatinous matter which melts in boiling water. Notwithſtanding its denſe and cloſe texture, it manifeſtly ſuffers elaſtic fluids, and vapours to tranſpire from the interior of the egg outwards, and from without into the interior of the egg; it is upon this principle that we may explain the loſs of weight which the egg experiences when it is kept in dry air, and the action which acrid or deleterious vapours exert upon the chicken incloſed in it. Anatomiſts have injected this membrane and proved its communications with the texture of the white. The ſhell, formed of ſmall granulated bodies, placed by the ſide of each other, entirely perforated with ſmall holes and ducts, which are diſcovered in it by the art of injection or the tranſudation of coloured liquids, is not ſolely compoſed of carbonate of lime mixed with gelatinous ſubſtance as had long been believed; but it alſo contains a portion of phoſphate of lime, which even the weak acids diſſolve

dissolve with ease, as it is disseminated in a large quantity of calcareous carbonate. This solid shell is deposited after the white in the canal of the oviduct upon the yolk that has descended from the ovarium, during the time that this yolk remains in the canal, (see the Article concerning the Excrements.)

B. Of the Feathers.

10. I HAVE spoken, in the first number of this article, concerning the beauty and variety of colour of feathers. I shall here treat of their nature as applied to the principal uses for which they are destined. The feather is in general a round, horny, transparent tube, filled with a mucous marrow, terminated by a solid prismatic part, and provided in that part with plumes placed obliquely upon the two opposite sides. The difference which exists between the feathers, according to the situations in which they are placed, and the functions for which they are destined, depends chiefly upon the relative size of the cylindrical canal, and the solid part, and of the length and strength of the plumes. One sort, the smallest, are only like scales or integuments covering the body and defending the skin, the others, those of the wings or of the tail, are strong and long ducts, the sides of which are hard and solid, having the full and prismatic part drawn out to a great length and tapered, with broad and

and extenfive plumes, which prefent a ver large furface to the air or the water which the are deftined to ftrike. Thefe laft-mention parts, the plumes, are themfelves very mu varied, elongated, flattened, clofe, feparat fimple or ramified, ftraight or curled, accordi to the variety of functions which they a deftined to fulfil.

11. The nature of the feathers fingularl refembles that of horn in general; in the fi they melt, become brown, fume, exhale a ftron oily and ammoniacal fmell, they fwell and a laft inflame, leaving afterwards a brown o black light cinder, difficult to be calcine little faline, containing phofphate of lime, little carbon and frequently phofphate of iro Diftilled in a retort, feathers afford a feti water, a denfe and almoft concrete oil, ca bonate, pruffiate, and zoonate of ammonia, ca bonated and fulphurated hidrogen gas. Boili water foftens and at laft diffolves the corneo matter, and reduces it to the gelatinous ftat the acids and the alkalies foften and diffolve alfo; many of the colouring matters attac themfelves eafily, and adhere ftrongly to t furface of the feather and efpecially of i plumes. It is known that an ingenious a exifts of dyeing feathers and giving them a poffible tinges.

C. (

C. Of the Dung of Birds.

12. THE excrements of birds have a very diſtinct character, and properties very different from thoſe of the excrements of man, and the the mammiferous animals. Two matters very remarkable by their differences, are conſtantly diſtinguiſhed in the dung of birds; the one, which frequently is the moſt abundant, is of a dark-green, or brown colour; the other white, and drier than the preceding. In general, the fetidity is not ſo ſtrong in the excrements of birds, as in thoſe of other animals. It is known alſo, that the urine which has no other out-let, paſſes off by the ſame emunctory, and that it is in very ſmall quantity. Finally, there is frequently remarked on the outſide of the excrements of birds, a glairy matter, more or leſs tranſparent, analogous to the white of egg, and which indeed appears to be only a ſuperabundance of the albumen, that lines the ſuperior part of the oviduct, which is carried along with the excrements.

13. The coloured part of the dung of birds, is an alimentary reſidue, like that which compoſes the greater portion of all the excrements; but the white part is of a quite different nature; we find in it by analyſis, all the characters of a mixture of carbonate or phoſphate of lime, and of albumen. It is therefore the ſame ſub-

ſtance

ſtance which conſtitutes the ſhell of the egg, and it appears in fact, that having the ſame origin and being in the ſame place with it, it can only be conſidered as the ſuperfluity of that which ſerves to form the concrete and ſolid covering of the eggs. It ſeems that this kind of evacuation correſponds with that of the phoſphate of lime, which takes place by the urine in man, and in the depoſition of the ſame ſalt, in the horns, the hair, and the hoofs of the mammiferous animals.

14. It is known in agriculture, and in the practice of ſome of the arts, eſpecially in that of the tanner and the ſkinner, that pigeons' dung is a ſort of acrid matter, which forms a hot and very active covering for the earth, and a very energetic agent for the ſoftening and ſeparating of the hairs. Citizen Vauquelin, in a firſt inquiry upon the dung of the pigeon, made in hopes of diſcovering the cauſe of its utility in the preparation of ſkins, has found that this excrement ferments with great promptitude and energy, and that it contains a pretty ſtrong acid, which has appeared to him to be of a particular nature, different from that of all the known acids. I have already remarked, in a preceding article, that it is pretty frequent to find a character of acetous acidity in the human excrements; thus, the aceſcence may one day be reckoned amongſt the properties, which belong to the reſidue of digeſtion.

D. Of

ies which they prefent, or even the dangers rith which they threaten us, or the fears which hey infpire. Thefe are the tortoife, the lizard, he fcink, the toad, the frog, and the viper: we fhall fay a few words concerning each of thefe fpecies.

A. *Of the Tortoife.*

2. THOUGH moft of the fpecies of the tortoife may be ranked amongft the emollient and nutritive aliments or medicines; though fome of them even afford difhes that are in high efteem, fuch as the eggs of the fea-tortoife: it is efpecially the frefh water or land-tortoife, called alfo the common or muddy turtle, *teftudo lutaria*, which is the moft generally employed, and the moft ufeful. If it be not correct to confider it as a valuable remedy, and to attribute to it the antihectic and antipulmonic property, on account of which it has been prefcribed in broths by the French phyficians; it is ufeful at leaft to know, that its flefh affords a mild and wholefome nutriment, that it nourifhes eafily and abundantly, that navigators find in it when on fhore, an aliment very well adapted for removing the fcorbutic affections, with which they are fo frequently attacked; and that fome nations make a very frequent ufe of it. This flefh is eafily reduced into

into a jelly, by decoction in water; the broth ſoon grows ſour.

3. The covering of ſeveral kinds of tortoiſes, is one of the matters that are moſt frequently, and the moſt uſefully employed in the arts, under the name of tortoiſe-ſhell. This ſhell is formed of hard, and ſomewhat flexible layers, more or leſs thick, cloſely applied to two oſſeous bucklers, attached to the ſpine and the ribs: that of the back is called *carapace*, and that of the belly, *plaſtron*. Theſe laminæ when detached, are ſawed, cut, turned, poliſhed, ſoftened, curved, moulded, in a word, a multitude of very varied forms are given to them. The tortoiſe-ſhell has a great analogy with horn, its firmer texture, is ſuſceptible of a finer poliſh; its red or browniſh colour, frequently ſpotted and clouded, renders it more valuable for thoſe utenſils, in the fabrication of which it is employed. As it is ſuſceptible of being ſoftened by boiling water, its powder and chips are ſhaped into any forms that are deſired by melting it in boiling water, and with the aid of moulds; figures, a kind of baſſo relievos, or engravings in intaglio are imprinted upon it; it is in this manner that boxes are fabricated of the fuſed ſhells.

B. Of

B. *Of the Lizard.*

4. THE genus of lizard, which is charaɕterized by a long body, four ſhort legs, a long tail, thick at the baſe, and continuous with the body, comprehends the crocodile, which was formerly made uſe of in medicine; the guana, a large lizard of America, the fleſh of which is excellent food; the cameleon, famous for the changes of the colour of its ſkin, of which fabulous accounts have been given; the ſalamander, whoſe gluey humour has cauſed it to be conſidered as capable of extinguiſhing fire, and conſequently of preſerving its life in the midſt of burning coals; finally, the grey and green lizard, commonly an inhabitant of our temperate climate, and the warm parts of Europe, and the ſcink which is found in Africa: theſe two laſt merit our particular conſideration, and I have diſtinguiſhed them under this point of view, in the claſs of reptiles.

5. The common, or grey lizard, which dwells between the ſtones of old walls, and lives upon inſeɕts, is remarkable for its ſlender form, and rapid pace. Its fleſh is very good to eat; and were it larger, it would be as much eſteemed as the guana of America. It has been extolled as a ſort of ſpecific in diſeaſes of the ſkin, eſpecially in herpetic eruptions, and even in cancers; it is adminiſtered broiled, as food. This ſpecific virtue

virtue has been eſpecially attributed to the green lizard, remarkable for its brilliant colour, and more frequent, and larger in the hot countries of Europe, than in the temperate. Its fleſh has a ſomewhat ſtronger, and ſenſibly aromatic taſte. Unprejudiced phyſicians conſider neither of them as any thing more, than a ſimple nutriment, which, when ſubſtituted for another, is capable of modifying for ſome time, the nature of the humours, and thus producing ſome changes in the individuals who uſe it.

C. *Of the Scink.*

6. The ſcink, *lacerta ſcincus*, is a ſmall lizard, of a ſilver-white colour, with a tail ſhorter than its body, and with very ſhort legs, which inhabits the dry places of Africa. A conſiderable traffic was for a long time made with it into Europe, becauſe it was formerly employed in medicine. It was exported, when dried in the ſun, and become brittle. An alexiterial, and particularly a reſtorative virtue, was attributed to it. It was prepared in broths; it was adminiſtered even in powder; but as it was aſſociated with ſeveral other aromatic, acrid, and hot matters, virtues were attributed to it, which belonged only to the medicines, with which it was preſcribed. In fact, it is merely nutritious, like the common lizard.

D. *Of the Toad.*

7. THIS is another reptile that has been the ſubject of prejudices of every kind, and which, from ignorance, has been both an object of terror and a medicinal ſubſtance. The form, the diſguſting colour of the toad, *rana bufo*, have cauſed it to be reckoned amongſt the poiſons. Its bile, its ſlaver, its urine, and its tranſpiration, have been dreaded. None of all theſe fears has any juſt foundation. It is equally erroneous to ſuppoſe, that it poſſeſſes the important medicinal properties that have been attributed to it; it is neither fit for expelling all kinds of poiſon out of the body, nor capable of reſtoring to perſons, debilitated by long continued diſeaſes, the vigour and ſtrength that had been expected from its uſe. Theſe virtues were thought to be communicated to it, or preſerved in it, by leaving it to die expoſed to the ſun, after having ſuſpended it by one of its hinder legs; by ſhaking, and whipping it with rods; it was preſerved dry; its powder was employed in à multitude of alexiterial, alexipharmic, and cordial compoſitions; it was ſubject to diſtillation, the volatile ſalt that was obtained from it, was preſerved, &c. More than forty years ſince, its pretended virtues have been conſidered fabulous, and its medicinal uſe ridiculous and futile.

E. *Of*

E. *Of the Frog.*

8. The frog, *rana esculenta*, which affords a light, wholesome, and sufficiently agreeable aliment, was formerly also ranked amongst the medicinal substances. The glairy and gelatinous humour which envelopes its eggs, was particularly used under the name of spawn, *sperniola*; it was applied to painful or inflamed parts, in order to allay the heat and pain; the water obtained from it by distillation, was likewise employed. The whole frog, especially that which inhabits thickets, and which is known by the name of *rana arborea*, was considered as capable of allaying febrile heat, when held alive in the hand. It was also given in broth, to produce the same effect. This last use, that of forming a mild and refreshing broth, is the only truly rational one, to which it can be applied.

F. *Of the Viper.*

9. The viper, a species of the genus *coluber*, called *coluber berus*, characterized by 146 ventral plates, 39 caudal pairs, a compressed, flat, triangular, scaly head, a grey skin, marked with two rows of brown spots, disposed in zigzags upon the back, presents two kinds of considerations,

fiderations, upon which chemiftry may throw fome light, and which confequently belong to her province. The firft relates to the medicinal and economical ufe of the whole; the fecond comprehends what belongs to the venom of this ferpent, to its nature, its effects, and the means of deftroying them. I muft take a hafty view of them, under each of thefe relations.

10. Formerly, fuch a number of virtues, and thofe fo very important, were attributed to the viper, that there was not within the whole power of the art, a more important remedy, or one that was employed in a great number of difeafes, with fuch unbounded confidence. Its flefh was an ingredient in the famous broths, which, befides their reftorative properties, were fuppofed to act as fpecifics in difeafes of the fkin, and of the lungs, and efpecially in the chronic affections of the lymph, as well as in malignant fevers, in agues, and even in the plague, the itch, and the fcurvy. Their depurating property, attributed to a volatile or aromatic part which was fuppofed to exift in them in large quantity, was extolled without reafon, and without bounds.

The head of the viper dried, was thought to combat all poifons, and particularly that of the animal itfelf.

The liver and heart of this ferpent, dried and pulverized, was fuppofed to poffefs a great activity, and the pompous name of animal bezoar, was given to them. The fat paffed for a fudorific,

 refolvent

resolvent and anodyne, its gall for a detergent, and eminently adapted to the diseases of the eyes.

The volatile salt and the spirit, or the ammoniacal oily carbonate, and the water charged with this salt, that were obtained from it by distillation in the retort, were also prescribed.

All these grand qualities reduce themselves to the alimentary nature of its flesh, which is perhaps a little more irritating and active, when compared with that of the mammalia, and the birds.

11. The history of the poison of the viper, is of much greater importance, than that of the entire animal, considered as a medicine. The last is almost entirely hypothetical; the first, which is entirely experimental, has enlightened us, respecting a danger, which, not unfrequently menaces our own existence, or that of animals valuable to us. Fontana, after Redi, Charas, Mead, Nichols, and James, have made researches, which have given a great degree of accuracy to this history. The viper, like every other kind of poisonous serpent, has in its upper jaw, two large canine teeth, frequently surrounded at their base, with several other smaller teeth, bent backwards, and designed, either to bite together with them, or to supply their place when they fall out. These teeth, implanted in a wide alveola, and covered at their base with a membranous reticular texture, are curved

curved towards the bottom, and very ſtraight at their point, which is extremely ſharp. Beſides a blind triangular cavity, a kind of ſinus, occupying as in all the teeth, the greater part of it, the venomous tooth is perforated by a conical channel which opens towards the bottom by a triangular hole in the reticular texture, and by an elliptical fiſſure under the point of the tooth. Theſe two apertures, placed at the two extremities of this canal, are ſituated upon the connected part of the tooth; that from below, receives, by a membranous duct, the venomous humour which flows from a triangular tendinous veſicle, ſituated upon the lateral part of the upper jaw, at a certain diſtance from the tooth, and compreſſed by a very ſtrong muſcle; so that the poiſonous humour is not contained in the texture which envelopes the baſe of the tooth, but conveyed by a duct which perforates the maxillary bone, and communicates immediately from the veſicle with the baſe of the dental duct: in biting, it iſſues from the last-mentioned duct, through the elliptical orifice which occupies its extremity, and with which the lower part of the point of the tooth is grooved.

412. It is well proved by the experiments of Fontana, that the yellow humour, proceeding from the maxillary veſicle, compreſſed by the effect of the bite, arriving immediately at the dental duct, without entering the reticular texture, and diſcharged by the elliptical orifice,

 ſituated

ſituated under the point of the tooth, is the true poiſon of the viper; that the ſaliva and the buccal humour are not venomous; that the bite without this diſcharge, whether on account of its being exhauſted, or on account of the veſicle being taken away, or its duct tied, has nothing venomous or dangerous. The poiſon of the viper, is therefore attached to the nature of this humour, and its chemical examination has become an inquiry of the greateſt importance. The phyſician above-mentioned, has neglected none of theſe reſearches; ſeveral thouſands of theſe animals, which he procured very eaſily at Piſa, were ſacrificed to his experiments, of which I ſhall here preſent the reſult in as precise a manner as I am able. The venom of the viper, is not a poiſon to its own ſpecies; it does not kill leeches, ſlugs, ſnails, aſps, ſnakes; tortoiſes are not killed by it without much difficulty. It is neither acid nor alkaline; it contains no ſalts that cryſtallize by evaporation, and the ſtreaks that divide it when it dries, have been erroneouſly conſidered to be ſaline cryſtals. It has no decided taſte when applied to the tongue; it is neither acrid nor burning, like the humours of the bee, the waſp, and the ſcorpion; however, it is not inſipid, but leaves for ſeveral hours a ſenſation on the tongue, ſimilar to that cauſed by aſtringents. The animals, dogs eſpecially, ſeem to reliſh paſtry and bread impregnated with it. It excites no pain in the wounds,

nor inflammation in the organs upon which it is applied.

13. The venom of the viper is yellowiſh, ſomewhat viſcous like a mucous liquor; on account of its unctuoſity, it reſembles an oily liquid in appearance; it is inodorous, thickens quickly in the air, and becomes ſimilar to a tranſparent jelly; it then adheres ſtrongly to the teeth, like pitch. It is not in any degree inflammable when expoſed to the fire. When it has become dry by long expoſure to the air, it ſtill preſerves its venomous property, and on this account we ought to be upon our guard in handling dried vipers' heads; however, ten or twelve months keeping ſeems capable of deſtroying its deleterious property. It dilutes itſelf in water, and diſſolves in it when it is agitated; if we throw it into water at the moment when it has juſt been extracted from the veſicle, it immediately falls to the bottom after the manner of ſome heavy oils. It preſerves for ſome time its colour, its viſcoſity, and its particular exiſtence; hot water diſſolves it after its deſiccation; alcohol does not diſſolve it; it is not coagulated by boiling water; the acids or the alkalies do not ſenſibly alter or diſſolve it. The aqueous ſolution of the poiſon is precipitated by alcohol; it cracks in drying, after it has been precipitated, and in all the experiments, it ſhows ſo much analogy with gum, that Mr. Fontana calls it an animal gum.

14. Whilſt

14. Whilſt it was impoſſible for the ſcience to determine *a priori*, or according to its known nature the manner in which the venom of the viper acts upon animals, it only remained to inveſtigate, by the effects themſelves upon the animal economy, in what this action conſiſts; and this has been done by Mr. Fontana. This humour certainly does not act either by its acidity or its ſaline acrimony, as it poſſeſſes neither of theſe qualities. It reſembles opium in its action; it diminiſhes and deſtroys the irritability of the muſcles; it coagulates and blackens the blood, it excites putrefaction; it is in this manner that it kills animals. The part bitten by a viper is manifeſtly diſeaſed, inflated, livid, ſphacelous. When injected into the veins, the poiſon kills ſtill more quickly; it acts more ſpeedily upon the animals with hot than upon thoſe with cold blood. The danger of the bite is ſo much the greater, and death ſo much the more certain and ſpeedy, as the animal is leſs ſtrong, and leſs heavy. Man and the large animals do not ordinarily die of the bite of a viper, and it is requiſite that theſe ſerpents ſhould be multiplied in proportion as the animal is heavier, in order to produce this effect. There exiſts, therefore, a relation between the bulk and the ſtrength of the animal, and the active and deleterious property of the poiſon of the viper.

15. The venom conveyed, either by the tooth itſelf or by other means, into a ſuperficial

wound

wound of the ſkin, is not mortal. If the ſkin is deeply penetrated, the diſeaſe which it produces cauſes death; it even takes place when it is introduced into the cellular texture; in the muſcle or at its ſurface, it produces a ſevere but ſeldom a fatal diſeaſe; after having killed one animal it may kill another. It has no action or only a very weak one upon ſome of the membranes, the pericranium, the perioſteum, the dura-mater, the bones, the marrow, the ſclerotic, and the cornea. The wound made in the comb of the cock by a venomous tooth, is followed by a veſicular tumour in the wattles of this animal; a wound in the nape of the neck in Guinea-pigs, produces a tumour upon the breaſt or the chin. When the noſes of rabbits or of Guinea-pigs are wounded, it ſwells; a tumour is formed under the chin and thoſe animals recover; in dogs and cats, the ſame bite, repeated to the number of four and twenty times on the noſe, produces a conſiderable inflation, without wound or ſcar, and they recover in a few days.

The venom does not act upon ſeparated members and muſcles, though applied at the moment of amputation; it requires a communication in the living parts in order that its action ſhall take place. Its action announces itſelf after twenty ſeconds by the lividity which it produces; if the bitten part is amputated before this period there is no danger; when twenty-

five

five feconds have elapfed after the bite, it is too late.

The venom produces two difeafes, the one external, followed by lividity, fwelling and mortification; the other internal, affecting the blood, the large veffels, the heart, and the lungs.

When injected into the jugulars of rabbits in the dofe of fome drops diluted with water, the venom immediately kills them, with a pain which caufes them to omit piercing cries. The blood is found coagulated and black in the ventricles and auricles, and black and liquid in the other regions; the lungs fpotted and diftended, and the inteftines inflamed as well as the mufcles of the abdomen and the thorax. The venom mixed with fix or feven parts of blood at the moment when it is drawn, prevents it from coagulating, blackens it, renders it fluid, and prevents the feparation of the ferum. The caufe of death in confequence of the venom, is the alteration produced upon the blood, and confequently upon the vital organs, which lofe their irritability and go on rapidily towards putrefaction. Animals with cold blood, die much more flowly of it, becaufe they can difpenfe for fome time with refpiration and motion without perifhing.

16. M. Fontana, has terminated his experiments with numerous trials of a multitude of fubftances or means that have been propofed for curing the difeafe produced by the bite of the viper. He has afcertained that ammonia,

the acids, and the ſalts in no wiſe diminiſh its dangerous effects; that the oils are of no uſe; that cantharides are ineffectual; Peruvian bark little efficacious; theiraca of no effect; the fat of the viper as well as hartſhorn calcined to blackneſs entirely inert; that ſcarifications and the application of electricity are more prejudicial than uſeful, by accelerating and augmenting the local diſeaſe; that the warm bath diminiſhes the danger, which ceaſes on a ſpeedy amputation of the bitten part; that the application of leeches and ſuction are of no utility; that ligatures ſometimes effect a cure; that the lapis cauſticus is the only conſtant and certain ſpecific when it is mixed with the venom, or when it can reach it before it has entered into the circulation; that this remedy fails when the very ſmall wounds are cloſed by the elaſticity and contraction of the parts: finally, that the virtues attributed to ſome remedies, and the cures that have been thought to be made upon bitten perſons by them, depend upon the circumſtance that it was not known that men do not die of theſe bites, but experience only more or leſs violent diſeaſes, which is however curable by the mere powers of nature; in fact, this diſeaſe may be aggravated by fear, by the moral affections, and even by the inconſiderable remedies which are generally preſcribed. M. Fontana has calculated, that if a thouſandth part of a grain of the venom of the viper is ſufficient to kill a ſparrow that weighs an ounce;

if

if it requires five or ſix times as much to kill a pigeon of the weight of ten ounces, it would require twelve grains to kill an ox weighing 750 pounds, and three grains for a man weighing 150 pounds; that is to ſay it would be neceſſary to accumulate the bites of twenty vipers, in order to produce the death of an ox, and of ſix to kill a man.

17. The ſtate of the ſcience permits me to add to theſe reſults of M. Fontana, that potaſh or the ſolid cauſtic fixed alkali, is probably not the only remedy capable of deſtroying the dangerous properties of the venom of the viper, that ſeveral cauſtics, by diſorganiſing the ſolids of the animals, and ſuddenly altering the nature of their liquids, may anſwer the ſame purpoſe if adminiſtered ſoon after the bite; that the nitrate of mercury, that of ſilver and eſpecially the ſublimed muriate of antimony, which are employed with ſuch decided ſucceſs for changing the nature of the hydrophobic virus, cannot fail to exert the ſame energy upon the venom of the viper: that there is reaſon to believe that the oxigenated muriatic acid will have the ſame advantage, as it is ſo well adapted for changing the nature and properties of the animal liquids, and as experience has confirmed what I firſt announced reſpecting its energy in deſtroying the variolous virus. But in order that all theſe re-agents may act as real counter-poiſons, it is neceſſary that they ſhould be ſpeedily, and certainly introduced

into the wounds; that they ſhould be brought into exact contact with the venom; that they ſhould reach it before it has been able to penetrate into the veſſels, and that their adminiſtration ſhould be conducted in ſuch a manner as to leave no doubt in this reſpect.

ARTICLE XXXI.

Of ſome Matters peculiar to Fiſh.

1. THE fiſhes do not furniſh to the arts and human induſtry ſo great a number of matters as ſeveral other claſſes of animals. They afford a large quantity of alimentary matter, and numerous nations live upon their fleſh which is no leſs various than wholeſome. It is ſufficiently known what differences of taſte, colour, conſiſtence, and digeſtive property, this kind of nouriſhment preſents. We know in this kind of fleſh the very remarkable differences between that of the fiſhes, of the freſh-water, the river, the rivulet, the brook and the ſtagnant waters, of thoſe that inhabit clear and thoſe that dwell in muddy water, of the fiſhes that ſwim at the ſurface, and of thoſe that keep at the bottom of lakes. The cauſes of all theſe differences, which the palate appreciates ſo exactly, and which are no leſs diſtinguiſhable by the ſtomach, have not yet been inveſtigated by chemical analyſis, though they

they promise useful discoveries and imp results for the science of nature. It is e necessary to determine what distinguish nature of the flesh of fishes from that of bir mammiferous animals; and this object is important for the advancement of phyfics.

2. Credulity, and the hope of assuaging or ing diseases, had formerly introduced int dicine several matters, liquid or solid, belc to fishes, which the discoveries of our ag caused to be rejected and ranked amongst i indifferent substances: such are the bones head of several of these animals, those are found near the vertebral column carp, the elongated bones of the interior head of the pike, and the whiting which bel the organ of hearing; marvellous propertie attributed to them, which it is useless her to call to recollection. The qualities gall of the pike, of the tench, of the and especially of the eel were also muc tolled. To their highly exalted stomachi tues, particular and specific virtues were which a more rational examination has en rejected. In considering here, under thei general relation, the principal utilities c products of fishes in the arts, independent of alimentary property, I confine the mat that are borrowed from this class of anim four principal substances; namely, isin or fish-glue, the oil which is extracted

se

ſeveral fiſhes, the ſcales with which they are covered, and the bones which conſtitute ſome portion of their ſkeletons.

A. *Of Iſinglaſs.*

3. Isinglass or fiſh-glue, is a dry, white, ſemi-tranſparent matter, bent into the ſhape of a lyre, and formed of a membrane rolled together. It is prepared upon the borders of the rivers in the vicinity of the Caſpian and Black Seas, by taking out the ſtomach and large inteſtines of the great ſturgeon, *acipenſer huſo*, rolling them into a kind of cylindrical cords, after having cut them longitudinally, then expreſſing them, and drying them in the air ſuſpended to ſtrings, to which they are attached by their two extremities: when theſe membranes are almoſt dry, the form of a lyre is given to them. The fibrous aud elaſtic texture of iſinglaſs, prevents its becoming dry and brittle, like the glues. It may be prepared with all the parts, and eſpecially with the air-bladders of fiſhes of a large ſize. That which is very white and of a fine texture, is preferred.

4. Fiſh-glue is of a faint and inſipid taſte. It burns upon ignited coals, ſhrinking together, and diffuſing a fetid ſmell, like all the animal ſubſtances; diſtilled in the retort, it affords the ſame products with theſe ſubſtances, and eſpecially

cially a pretty confiderable quantity of oil and carbonate of ammonia. It is unalterable in the air, on account of its dry ftate; cold water foftens and feparates the lamellæ of the ifinglafs, with the aid of maceration. By this means we may unfold, and at the fame time extend it. Boiling water diffolves, and gives it the form of a jelly; accordingly, it is ranked amongft the gelatinous fubftances. The weak acids diffolve it, and the alkalies precipitate it from them.

5. Ifinglafs may be confidered as an alimentary matter: foftened or diffolved in water, it forms a very nutritious jelly, to which only the feafoning need be added: accordingly, it forms the bafe of a great number of difhes for the table. It is affociated with the acid juices of fruits, with aromatics, and with fugar.

Confidered in a medicinal view, ifinglafs is ranked amongft the emollients, relaxants, incraffants, it is prefcribed in difeafes of the throat, the inteftines, the urinary paffages, and even in affections of the lungs.

Its moft frequent domeftic ufe is in the clarification of liquors, of wine, of coffee, &c.; fmall fragments are thrown into boiling coffee, and it becomes clear in a few minutes.

B. Of

B. *Of the Oil of Fish.*

6. We muft not confound, under this deno- ination, the oils which are extracted from the hale: we here treat only of the oil of fifh, pro- rly fo called, of that which is extracted from rrings, and a great number of other fifhes, bjected, after having been heaped to- ther for fome time, either to the operation of prefs, or to the action of boiling water, at the p of which the oil collects.

No animal matters are more replete with fat ıd oil, than the flefh of fifhes. The dif- rence of the organ of refpiration in thefe ani- als, the little evacuation and combuftion hich the carbonated hidrogen experiences with hem, eafily explains the fource of the oily uice, fo abundantly formed, and diffufed in heir organs. Accordingly, they are almoft all apable of affording this product, though it is xtracted only from thofe which are the moft umerous, which live in fhoals, and which are aught in great abundance.

7. All fifh-oil has a fetid difagreeable fmell, nd it is difficult to conceive how fome nations an ufe it as feafoning and aliment. It has an nalogy with whale-oil; it burns eafily with white flame; it is congealed by a flight degree f cold, and feems pretty eafily to affume the ryftalline form. It alfo appears fufceptible

4 of

of being quickly changed into an adipocirous matter, of which it contains a portion ready formed. By repofe, are feparated from this oil, flakes and laminæ of matter, fimilar to fpermaceti, which depofit themfelves at the bottom of the veffels in which it is kept.

Fifh-oil is chiefly employed in the arts that are practifed upon fkins, in order to foften them and preferve their pliability: it is alfo ufed in lamps. Some indigent nations ufe it as aliment.

C. *Of the Scales of Fifh.*

8. The fcales of fifh are remarkable for the beauty of their colour, and the filvery luftre of their furface; for their ftructure and reciprocal arrangement, which forms a continuous integument for the whole body; for the oily and mucous humour, which renders them impenetrable by water; finally, for their nature, analogous to that of horn or tortoife-fhell, which, whilft it gives them folidity, preferves in them a flexibility and elafticity, whereby they are enabled to accomodate themfelves to all the changes of form which the bodies of fifhes affume. The fcales adhere to the fkin, with which they appear to be continuous at their margins; they alfo refemble it in texture, and prefent the fame chemical properties. Long ebullition in water, foftens them, fufes them, and changes them

into

to gelatin, lefs quickly indeed than the fkins ' fifhes deprived of fcales, or covered with e and thin fcales, fuch as thofe of lampreys, d efpecially of eels, which, it is known are ployed in the preparation of glues, ufed in inting.

9. In feveral fpecies of chondropterygian es, the fkin, when deprived of fcales, is quently charged with hard, cartilaginous or eous tubercles, fufceptible of polifh, tinged fome fpecies with blue, green, and grey co-urs. This tuberculous fkin, is employed for orning and covering feveral fmall pieces of niture, that are liable to blows or friction. e hardnefs of thefe tubercles, when they are all, equal, and clofe, renders the fkins of fome thefe fifhes very ufeful to be employed like fp or file by cabinet-makers.

0. The moft ingenious ufe to which the es of fifhes are applied, is in the fabrication tificial pearls. In order to give to the fmall bes of thin blown glafs, with which they fabricated, the pearly brilliancy which cha-rizes the natural pearls, a mode has been trived of attaching the fine filvery fcales of -water fifhes to their interior furface. The k, *cyprinas albula*, a fmall river-fifh, one of the moft brilliant and filvery that own, furnifhes in its thin and delicate s, the colouring matter of the falfe pearls. fifhes are taken with nets, they are rub-gainft each other in buckets under water;

 the

the fcales detach themfelves, and fink to the bottom of the water; they are collected and flightly dried; they are afterwards put into liquid ammonia a little diluted, in which they foften, and this liquor is blown into the glafs pearls, upon the fides of which the fcales apply and glue themfelves: it is called *effence oriental.* The ammonia preferves the fcales with their brilliancy and frefhnefs for feveral months.

D. *Of the Bones of Fifhes.*

11. The fkeletons of fifhes vary in the different orders of thefe animals. Two kinds of them are diftinguifhed; the one foft, pliable, femi-tranfparent, fimilar to cartilage, on which account the fifhes in which it exifts have been called *cartilaginous*; thefe bones are found in the fkate, the fea-dog, &c. The other is folid and truly offeous; all the bones of this kind, terminate in fharp points, on which account, the fifhes in which they are found have been defignated by the name of *fpinous fifhes.* The analyfis of thefe bones has proved that they confift, like thofe of the mammalia, and of the birds, of phofphate of lime mixed with gelatinous matter; the latter fubftance abounds more in them, than in the bones of the preceding animals.

12. Befides

12. Besides the domestic uses, to which several nations, little advanced in civilization, employ the teeth, the vertebræ, and other bones of fishes, substituting them instead of iron, which they have not, for fabricating their hunting and fishing instruments, and different utensils, I have already indicated the properties that were attributed to the bones of the head of the pike, the carp, and the whiting, and the general use that was made of them in medicine. It should be known that after the vain hopes entertained respecting the properties of these bones, had been relinquished, it was imagined that it would be adopting an exact idea concerning them, to rank them in the class of the absorbents. This was a new error, substituted in the place of the ancient one. The bones of fishes are not formed of carbonate of lime; the phosphate which constitutes them, cannot be considered as absorbent, as it does not attract the weak acid of the primæ viæ, with as much energy as the calcareous carbonate does. Accordingly, the bones of fishes, to whatever species they may belong, have not the qualities that had been attributed to them, nor can they fulfil the indications, to which they were formerly destined.

ARTICLE XXXII.

Of some Matters peculiar to the Mollusca.

1. THE mollusca, a class of animals without vertebræ, without interior skeleton, with cold and white blood, whose muscles are white, and very irritable, their skin humid and viscous, provided with tentacula, whose body is covered with a tegument, and frequently inclosed in a shell, which have the property of reproducing several parts of their body, when cut off, which, for the greater part inhabit the sea, or fresh water, present a great number of objects, with which it would be useful for chemistry to occupy itself. Such are especially the gluey and viscous humour of slugs which cover the places over which they crawl, with a slime, which hardens and appears to be calcareous; the soft, insipid, and gelatinous flesh of snails, which has been considered as proper for curing pulmonary affections; the white or blueish liquor, which supplies the place of the blood in the cuttle-fish and polypi; the colouring matter of the murex or purple-fish, which the ancients valued, and used so much; the threads, the silk or byssus which proceed from several shells

nd by which their inhabitants attach themselves to the rocks, all is replete with subjects for singular researches and discoveries in this class. Amongst the most generally known and useful objects relative to it, I shall treat in particular of the ink, and bone of the cuttle-fish, of pearl, of mother-of-pearl, of shells.

Of the Ink and Bone of the Cuttle-fish.

2. The cuttle-fish discharges, when menaced with any danger, exposed to blows, and especially when it is attempted to take him, a black liquid, which has been called ink, and which, forming a dark cloud round him, enables him easily to elude the search, and the view of his pursuers. This liquor, prepared in the body of the fish, by a peculiar glandular apparatus, is contained in a reservoir, which may be taken out, and in which we may obtain their ink, hard and brittle by desiccation. It is believed, that it is with this kind of atramentary animal juice, that they prepared in China, the solid ink employed in drawing, which is so remarkable for its indelibility, and its power of resisting the acids. It appears, that the ink of the cuttle-fish is actually a sort of coaly precipitate, insoluble in most re-agents, and suspended in a mucous liquor. It presents to the chemists who inhabit the sea-ports, a very interesting subject of experiments, for determining its nature, and ascertaining

afcertaining its utility in the arts : a truly in
lible ink might be prepared with this juice.

3. The common cuttle-fifh, *fepia officina*
contains towards its back, an oval, thick, fol
friable body, which is called *cuttle-fifh b*
and which is formed of thin plates, wi
numerous cells between them, in which
placed fmall hollow columns, perpendicul
with thofe plates. The nature of the body
gelatino-calcareous; it affords quick lime l
calcination, and jelly by long ebullition; it fol
ens very quickly in the acids, which diffolve
with effervefcence. It is feparated and dri
in order to employ it for feveral domeftic uf
It is recommended in medicine as aftringe
detergent, and at the fame time aperient a
emmenagogue. It is an ingredient in oin
ments, plaifters, powders, and collyria; it h
been efpecially employed in tooth-powders.
is alfo employed for making fome fmall moul
for cafting pieces of filver-ware; finally, it
fufpended under the name of fea-bifcuit, in t
cages of fmall birds, who amufe themfelves wi
picking at it, undoubtedly on account of t
faline tafte left in it by the fea-water, with wh
it has been penetrated.

B. Of

B. *Of Pearl and Mother-of-Pearl.*

4. Pearl and mother-of-pearl are two concrete matters, formed in ſeveral ſpecies of ſhells, or conſtituting part of them. Though moſt ſhells can furniſh theſe two kinds of concretions, it is nevertheleſs, from ſome particular ſpecies of muſcles and oyſters, that thoſe precious matters are extracted. They are rare in Europe, and their luſtre is not comparable to that of theſe productions in the oriental regions.

The river muſcles, eſpecially that of the Rhine, *unio margaritifera, mya margaritifera* of Linnæus, afford only an indifferent mother-of-pearl, in compariſon with the *avicula margaritifera, mytilus margaritiferus* of Linnæus, which inhabits the Indian ſeas, and from which the fineſt pearls and the moſt highly eſteemed mother-of-pearl are extracted.

5. The name of mother-of-pearl is given to the interior portion of moſt of the ſhells, whoſe fine and beautifully poliſhed texture is combined with the white ſilvery colour, and variegated with green, red, blue, and all the colours of the rainbow. We diſtinguiſh zones in it, which ſeem to indicate inequalities, projections, and ſtreaks at its ſurface, and which produce a great deception of the ſight. After having ſawed or corroded by acids, the exterior

part of the ſhells, as far as the layer of mother-of-pearl which they contain, the various forms requiſite for a multitude of different utenſils, are given to it by turning, chiſſeling, and ſeveral different operations, it is even ſoftened and bent with the aid of boiling water. It was formerly ranked amongſt the abſorbents; and its chemical nature actually allows us to admit this medicinal character in it; but there are ſo many other more ſimple and more eaſily procurable ſubſtances, which enjoy it in a much higher degree, that it has never been really employed for this uſe; it is reſerved for the fabrication of jewels.

6. The pearls, *margaritae, uniones*, vary greatly in their form, their ſize, their colour, their beauty, and conſequently in their price; they are generally irregularly roundiſh, or a little oblong, ſometimes pyriform, white, brilliant or grey, with ſilvery and coloured reflections. The brilliancy produced by theſe reflections, is called the *opaliſing of pearls*; the ſmall and more irregular pearls are called *ſeed pearls*; the large and ſpherical ones are ſcarce and dear. Very ſingular opinions have been entertained reſpecting the origin of theſe concretions. The ancients believed them to be formed of dew drops, collected in the month of May at the ſurface of the water, by animals that produce them. It is known, however, that the molluſcœ do not quit the ground and the bottom of the waters in

which

which they have been produced. Some naturalists have imagined the pearls to be an animal with a shell growing within another; imperfect observations have given rise to this system. Some learned men think that the pearl is a morbid concretion, arising from a puncture made in the shells. They assert, that pearls may be made to grow artificially, by perforating the shells of oysters or muscles, which contain them with holes. According to the most common opinion, they are simply regarded as a concretion, arising from the superabundance of calcareous matter.

7. Accounts no less various have been given respecting the seat of the pearls in the shells which contain them; the thickness itself of those shells, and the cavities announced externally by protuberances, even the hinge of the shells, or the prominent part of their articulation, and especially the ligament that attaches the two valves together, the fleshy body of the testaceous animals which inhabit them, or the interior of the shell in which they are found free and floating, as it were; these four situations have been successively assigned to them. It appears that they are most frequently placed towards the edges of the shells, inclosed under a membrane, which covers the mother-of-pearl, either lodged in cavities which this presents, or floating freely in the shell, or adhering to its internal surface, so that we are obliged to pull them away or detach them with more or less

force

force. It alfo appears, that the experiment of caufing them to grow artificially, by means of wounds made in the interior of the fhell, is not without fuccefs; and this accords with the anatomical facts which prove that wounds made at the exterior of bones, produce an internal offeous concretion or as thofe which are made towards the interior, or towards the marrow, or give rife to external offeous circles, exoftotic fwellings.

8. The pearl, as well as the mother-of-pearl, from which it differs only by its finer texture, is a compound of gelatinous matter and carbonate of lime. Cartheufer afferts, that the firft of thefe fubftances conftitutes only the twenty-fourth part of it, and that the twenty-three others are formed of the matter, which he calls *earthy* or carbonate of lime; but we muft include the water, which appears to be very abundant in this concretion. It is evident from this compofition, that the pearls muft be eafily foluble, even in the weakeft acids, and hence Cleopatra was able, if we may believe the Roman Hiftorians, to fwallow beautiful pearls diffolved in vinegar, in order to demonftrate her magnificence and wealth. But it is difficult to conceive from whence the opinion has arifen, which has been entertained refpecting the great virtues of pearls, and why they have been regarded as analeptic, fedative, cephalic, antiepileptic, bezoardic and cordial. They have been prefcribed, pulverized, in emulfions, and potions or mixtures, principally

incipally to quiet the anxieties produced in
ermittent fevers. They were afterwards re-
ced to the ſimple quality of abſorbent ſub-
nces, and ſince then, they have not been
ployed in medicine. Their uſe has long
en confined to the purpoſes of ornament,
r which they are employed, either alone or
mbined with a great variety of different jew-
which they decorate and enrich.

C. *Of Shells.*

9. The ſhells, ſo various in form, colour, and
e, which ſerve, by the diverſity of their
ucture, to characterize genera, and by their
lours or their appendages, to determine very
imerous ſpecies, the collections of which,
rm ſo pleaſing a ſpectacle, and preſent even
the learned, a ſeries of intereſting data, re-
ecting the ſtructure and the properties of the
imals which inhabit them, amongſt the
numerable varieties of theſe productions,
fer to the chemiſt only one ſingle ſubſtance,
perfectly homogeneous compound of carbonate
f lime, mixed with a little gelatinous matter,
lcinable into quick lime by heat, ſoluble with
fervefcence by all the acids, and ſometimes
ntaining a ſmall quantity of muriate of
da.

10. The chief and moſt uſeful purpoſe to
hich ſhells have been applied, relates to the
conſtruction

conſtruction of edifices. They afford very good and very pure lime, which is employed in all places in the vicinity of the ſea. It was formerly believed that the lime of oyſter-ſhells had very diſtinguiſhed medicinal properties, ſuperior to thoſe of the common lime; it had conſequently been highly recommended in the diſeaſes of the urinary paſſages, and eſpecially in the gravel and ſtone. At preſent, it is ſuppoſed that it cannot have any quality peculiar to itſelf, unleſs we conſider as ſuch the ſmall quantity of ſulphurated hidrogen gas, which is formed during the calcination of the ſhells, and which impregnates the lime-water which it affords, but it is known that this ſulphurated hidrogen can have no ſolvent action upon any of the conſtituent materials of the urinary calculi.

ARTICLE XXXIII.

Of ſome Matters peculiar to Inſects and to Worms.

1. INSECTS, whoſe hiſtory is ſo intereſting, whether on account of the beauty of their forms, of their colours, and of their varieties, or in the ſtudy of their ſtructure, their manners, their police, their combats, their habitations, the injury or the ſervices which they do to man, furniſh

nish a pretty confiderable quantity of ufeful ducts, or pernicious fubftances, the knowge of which is of importance, in order that may derive from the firft, all the advantages ch we can expect, and repel, or at leaft rect the troublefome influence of the fe-d.

. I fhall diftinguifh, efpecially amongft the t ufeful materials which we borrow from clafs of animals, the honey and the wax, cantharides, the millipedes, the ants, the a-lac, filk, cochineal, kermes and the crab-es, of which I fhall treat in particular in article. To thefe I fhall fubjoin the lum-i, or earth-worms; the only animals, which, ongft the pretty numerous clafs of worms, employed for feveral ufes, upon which che-try may throw fome light.

t is evident, that I omit in this catalogue ral infects, or feveral of their products, er becaufe they are rarely ufed, or becaufe r ufes have but flight relation with chemical wledge; or finally, becaufe I fhall indicate e of them in treating of the fpecies or mat- with which they have an analogy; I do fpeak of fome fpecies of fcarabei which have n propofed in medicine, of the wood-lice, the horns of the ftag-beetle, of the fca-eus monoceros, of the meloe, which has n given as a fpecific in hydrophobia, of the ıbi, of the cryfomelœ and lady-birds, ch are afferted to be capable of allaying the

the pain of the tooth-ache, by their mere contact, and which appear to communicate this property to the fingers which have touched them, of the coffus which were eaten by the animals, of the locufts which ferve as nourifhment to the acridophagi, &c.

3. Neither fhall I treat of all the pernicious infects, with which moft naturalifts have particularly occupied themfelves, as eating and deftroying cultivated plants, confuming the harvefts, &c. and the fubftances employed in buildings and clothes. I fhall likewife pafs over in filence, all the animals which belong to the province of natural hiftory, ftrictly fo called; the May bug and its larva, weevils moths, fermites, fcorpions, mole-crickets, and a number of other deftructive animals. I fhall alfo neglect thofe which attack man, and living animals, which fting them, fuck them, and expofe them to difeafes or accidents, more or lefs fevere, fuch as the bees, wafps, hornets, fcorpions: the laft-mentioned infects, however, produce an acrid humour, of which a knowledge may be acquired by chemical experiments. Mr. Fontana has already fubjected this humour to fome experiments, from whence it refults that with fome phyfical properties, and efpecially a gummy vifcofity, analogous to the venom of the viper, it contains alfo an acid ready formed, which renders it fufceptible of reddening paper, ftained with the juice of radifhes, and even of altering its colour. The humour of bees, received upon glafs, dries more flowly than

than that of the venom of the viper; fiſſures and angular lines are formed in it, which were taken for ſaline cryſtals by Mead; when dry, it diſſolves in water, but not in alcohol. Though it contains an acid, it cannot act by this principle, on account of the ſmall quantity and little ſenſibility of it. It is by being a venomous matter, that it produces pain; and there is reaſon to believe, that were it ſufficiently abundant, it would occaſion death, or the ſame diſeaſe as the venom of the viper.

A. *Of Honey and Wax.*

4. Honey and wax, though of vegetable origin, ſince the firſt is only the nectar of flowers, and the ſecond the pollen of their antheræ, both collected by the bees, are nevertheleſs produced by theſe inſects, which give them ſome characters of animal ſubſtances. Though the extraction and formation of theſe two matters are generally attributed only to the bees, there are, however, ſome other inſects of the ſame claſs, which produce analogous ſubſtances; but they are in ſuch ſmall quantity, that they cannot be extracted or compared with accuracy. In another point of view, honey and wax may be conſidered as materials of plants, ſince honey is nearly pure nectar, and ſince the fecundating powder, the

pollen

pollen of the flowers has very marked analogies with wax.

5. A great analogy has long been eſtabliſhed between honey and ſugar, both on account of its taſte, and the uſe which the ancients made of it, who knew the ſugar of the cane but very little, and did not employ it. But, beſides the difference of taſte which exiſts between thoſe two ſubſtances, and which is ſuch, that perſons habituated to ſugar, can no longer uſe honey, the aromatic ſmell, and the nature more or leſs animalized which diſtinguiſhes this product of the bees, does not ſuffer it to be confounded with ſugar, properly ſo called. Honey, whoſe colour, conſiſtence, taſte, and ſmell, vary greatly, according to the countries and the plants which the bees inhabit, or viſit, gives, by the action of fire and by diſtillation, the ſame products as ſugar; the nitric acid converts it into oxalic acid; it is very ſoluble in water; it is even deliqueſcent; it paſſes into the vinous fermentation, and forms a fermented liquor, which is called *hydromel;* it is partly ſoluble in alcohol, by means of which, a real concrete ſugar may be extracted from it; it is even pretended, that the ancients gave it this form. It is whitened by diſſolving it in water, and heating its ſolution with charcoal.

6. If we compare honey with ſugar, notwithſtanding the ſmall diſſimilarity which chemiſtry finds between theſe two bodies, we perceive

ceive that honey really differs from sugar by a somewhat acrid or faint taste, by a gold-yellow, greenish, or brown colour, by an aromatic or strong smell, by a liquid, or viscous, thick and ropy state, and by its deliquescence. If we investigate the cause of this difference, we shall find it in the presence of a colouring matter, of a mucous substance, of a sapid and odorous extract, which appear to be united with the saccharine matter, and not to be separable from it without much difficulty. It is to these particular properties, that the relaxant or purgative nature of honey is to be attributed, as well as the disgust which it gives to many individuals, who can consider it only as a medicine. Hence it is at present ranked more particularly in the class of remedies; it is reckoned amongst the laxatives, the emollients, the bechics, &c. It forms the excipient of many remedies, which are called compound honeys, such as the honey of roses, the mercurial honey, the honey of neauphar, &c. It is frequently combined with vinegar, and this mixture is called *oxymel.*

7. The wax does not exist ready formed in the powder of the antheræ, whence the bees extract it. No artificial means have yet been found for converting this pollen into wax; it is only the body of the bee that effects this conversion. After having swallowed the powder of the stamina, these insects discharge it in the form of ductile wax, by a kind of transpiration

which takes place between the rings of their abdomen, according to ſeveral obſervers, or by the mouth, with the aid of a kind of rumination, according to others. Some modern naturaliſts do not believe that the powder of the antheræ is the primitive matter of the wax, notwithſtanding the obſervations of Reaumur and B. Juſſieu. M. Della Roca, thinks that the wax is a vegetable ſubſtance, foreign to the pollen of the antheræ; that the open flowers furniſh only nouriſhment to the bees; that it is upon the buds of the thyme, upon the leaves of the fig, covered with ſmall tubercles, and perhaps upon the ſprouts of the poplar, and the extremities of the fir, that they collect the waxy ſubſtance, which appears certain, with reſpect to the two laſt-mentioned trees, relative to the collection of the propolis; that the plants contain the wax ready formed, and that the bees only purify it. But the propolis is not wax, ſtrictly ſo called, but appears rather to be a reſinous mixture, which has not yet been examined. Some naturaliſts think alſo that the matter of the wax collected by the bees, does not paſs into their ſtomachs, but that it is fabricated by the mere action of their mouths, and their paws.

8. The nature of wax is better known than its origin. Conſtructed into ſolid cells by the bees, it is turned yellow by the vapours, and liquids that iſſue from their bodies, as well as by the colouring parts of the vegetable matters, which they carry into their hives. Fuſed by a gentle heat,

heat, and deprived of the honey which it contained in the cells, it is run into thick, yellow, granulated cakes of rough wax; it is then melted, and in this ſtate poured into a cylinder, half immerſed in water, and which is ſucceſſively immerſed in it in all its parts, by a rotatory motion round its axis, imparted to it by a very ſimple mechaniſm. Rolled into thin ribbands by this firſt operation, it is afterwards expoſed to the air, and to the ſun, upon tiles, in order to bleach it, and when it has loſt all its colour, it is improperly called *virgin-wax*. In this laſt ſtate, it is employed for a multitude of pharmaceutical and domeſtic uſes: in that of raw wax it is likewiſe much employed.

9. All the properties of wax prove that this ſubſtance is a fixed oil, concreted by the proportion of oxigen which it contains. It is ſoftened by a gentle heat, and aſſumes all the forms which we chooſe to give it. At a low temperature, it is brittle, and ſhows a granulated and cryſtalline texture in its fracture. It melts at 45 degrees of the thermometer; it then preſents a white and tranſparent liquid; more ſtrongly heated, it is partly volatilized at a very high temperature; it is decompoſed into water, ſebacic acid, carbonated hidrogen gas, and an acrid oil; it then leaves ſome coaly marks. The concentrated acids burn it; the alkalies reduce it to the ſaponaceous ſtate; pot-aſh and ſoda particularly form with it a ſoluble ſoap, which is frequently employed by the name of *encauſtic* for painting pannel. It unites with

12. These four immediate materials of the cantharides are, separated from each other by water, alcohol and ether; hot water dissolves the extract, and melts the yellow oil; it even separates a part of the green oil; ether attacks the latter so well, that it may be employed with advantage for extracting it pure. This process is the more useful, as it is in the green wax that all the virtue of the cantharides appears to exist. A mixture of equal parts of alcohol and water, takes from these insects the green wax, and the extract which they contain, so that it is the most certain solvent which can be employed for preparing an active tincture of them. If we distil this tincture, the alcohol retains a slight smell of the cantharides, and the matters which it has dissolved, separate in proportion as the evaporation takes place. From 576 parts, (grains, or one ounce) of these insects, which he took for making his experiments, he obtained 288 of solid and insoluble parenchyma, 216 of bitter extractive matter, 60 of green, acrid, and odorous wax, and 12 of colouring yellow wax.

13. The vesicatory effect produced by the application of pulverized cantharides to the skin is well known. Mixed with ointments, they form the epispastic most generally employed, or the most common blistering-plaister. They produce a very singular action upon the bladder; the irritation which they produce in it, excites pain, a sense of acrimony, a difficulty

culty of making water, on which account they have been ranked amongſt the hotteſt diuretics. This action is moderated, and almoſt annihilated by camphor, when mixed either with the veſicatories, or with the tincture. Cantharides have been ſometimes recommended as a powerful aphrodiſiac, but many examples have proved that the ſlighteſt uſe that is made of them for this purpoſe, is an abuſe which is frequently followed by fatal conſequences. In all caſes, enlightened and prudent phyſicians never direct the internal adminiſtration of cantharides, or of any of their preparations, unleſs with the greateſt circumſpection, and in the weakeſt doſes. We ought alſo to diſtruſt the great hopes which have been formed of the effects of this violent remedy, in very ſevere, and even incurable diſeaſes. The green wax of the cantharides applied to the ſkin, produces a bliſter filled with ſeroſity.

C. *Millipedes.*

14. Wood-lice, *millipedes, aſelli, oniſci, porcelli,* are very well known inſects, of which there are ſeveral ſpecies, amongſt which that which inhabits low ſituations, and moiſt cavities, has been ſelected for medicinal uſe, or elſe that with a grey ſhining body, which is found under ſtones, and which, as it rolls itſelf together ſo as to form a ball, has on that account

count received in French the appellation of *porte armadille.* Thouvenel has examined t insects, on the nature of which, nothing had l said before his time. Distilled alone in the w bath, they yielded water sufficiently alka to turn the syrup of violets green: by this ration they lost ¼ of their weight. Tre afterwards with water and alcohol, they yie a fourth of their weight of extractive and v matter, which ether separated from each o by dissolving the latter without touching former. The expressed juice of these ins appears to contain muriates of pot-ash, an lime. The physician whom I quote has firmed the aperient and solvent property of juice in the jaundice, serous, lacteal gestions, &c. but in a much stronger dose, is generally prescribed.

D. *Of the Ants, and of the Formic Acid.*

15. In chemical analysis, ants presen sults of much greater importance than mo the other insects, on account of the well racterized acid which is extracted from t Langham, Tragus, Brunsfeld, and J. Ba discovered it by the red colour given tc flowers of endive in an ant's nest. Sa Fisher, Etmuller, Fred. Hoffman, afterw occupied themselves with it in particular. . graaff, investigating its character, verifie particular nature, and already found in fixed oil, and an extract. In more mo

ti

times, Thouvenel, Ardviſſon, and Oehrn, Afzelius, and Fontana, have made experiments upon this animal acid, and have determined its attractions and nature.

16. It is well aſcertained that ants, eſpecially the red, *formica rufa*, exhale, when collected in a maſs in a cloſe veſſel, a pungent acrid odour, which draws tears from the eyes and excites ſneezing. The air is ſpeedily altered by this vaporous body, and it ſoon ceaſes to ſupport combuſtion; it precipitates lime-water, and reddens the tincture of turnſole. Thus the ants convert the atmoſpheric oxigen into carbonic acid, and a part of their own acid is converted into vapour; when they are irritated, they diſcharge from their mouth a drop of brown or reddiſh liquor, very acrid, and very acid; cruſhed upon paper ſtained blue with turnſole, they give it a ſtrong red tinge; frequently even they produce ſtreaks of this colour upon the light-blue flowers, over which they creep: thus their acid nature is well marked, and all the experiments to which they are ſubjected, furniſh unequivocal proofs of it.

17. The acid of the ants has been extracted by three different proceſſes; by diſtilling them in the retort, by lixiviating them with hot water, and by extending pieces of linen impregnated with a ſolution of pot-aſh in an ant's neſt. In the laſt-mentioned caſe, the acid is combined with the alkali; the two firſt means have been preferred. The very acid liquor

which

which is obtained by the diſtillation of dried ants, by a well conducted fire, is covered with a little oil. This acid amounts to nearly half of the quantity of the inſects; its weight is to that of water, as 1,0075 to 1,0000. When it is extracted by means of hot water and by waſhing the ants, it is mixed with an oil. It has been adviſed to boil it, in order to purify and preſerve it. It is better rectified by diſtillation repeated ſeveral times, till the liquor paſſes off colourleſs. When highly rectified, its weight is to that of water, as 1,0453 is to 1,0000. It has a pretty ſtrong and not diſagreeable pungent ſmell; it is acrid to the taſte when pure; it becomes agreeable when it is diluted with water; it ſtrongly reddens the blue colours, it is turned black by the concentrated ſulphuric acid; it is rapidly decompoſed by the nitric acid, and by fire; it yields carbonic acid in this decompoſition. It has been compared to the acetous acid; it has been propoſed to ſubſtitute it inſtead of this acid for domeſtic purpoſes; and it has even been attempted to eſtabliſh this compariſon by poſitive experiments.

18. Notwithſtanding the pretty extenſive reſearches which have been made upon the formic acid for thirteen years paſt, its ſaline combinations have as yet been little examined. Thouvenel ſays that the formiate of pot-aſh, or the ſalt extracted from the cloths impregnated with alkali, and ſpread out in an ant's neſt, cryſtallizes in flat parallelograms or priſms that

are

e not deliquefcent. The formiate of lime is luble and cryftallizable. The other formiates ive not been defcribed. Meffrs. Ardviffon and ehrn have contented themfelves with indicat-g the elective attractions of the formic acid in le following order; barites, pot-afh, foda, lime, agnefia, ammonia, zinc, manganefe, iron, lead, n, cobalt, copper, nickel, bifmuth, filver, and lumine. Citizen Deyeux, has carefully ex-mined the acid of ants, and has found it to e analogous to the acetous acid.

19. Befides the particular acid of which I ave been fpeaking, the ants contain a fixed oncrefcible oil, which is extracted from them y the prefs, after they have been exhaufted of ll the foluble matter which they contain, by oiling water. This oil amounts to nearly a enth of their weight; it is of a greenifh yel-ow colour; it becomes fixed at a lower tempera-ure than the oil of olives; it approaches to the ature of tallow or wax. The water of the decoc-ion of ants gives, by evaporation, a fort of rown, fetid, acidulous, and cafeous extract, of a our, bitter, and naufeous tafte, from which alco-ol and water fucceffively feparate two different natters. After the oil and the extract obtained rom the ants, treated as has been faid, there re-nains a folid parenchymatous matter, which orms a fifth of their weight. Hoffman, by digeft-ng alcohol upon ants, obtained a colouring and romatic matter; and he called this tincture which orms a light precipitate with water, *fpiritus mag-nanimitatis*

nanimitatis, undoubtedly on account of its acrid tafte and aromatic odour. The fmell of amber which the ants have, and which they communicate to all the food which they touch, or in which they remain after having been drowned, is generally known. This fmell, which to many perfons is infupportable, has undoubtedly led phyficians to admit a cordial property in ants. However, I know a fact which ought to infpire fome diftruft with refpect to their medicinal ufe. A friend of mine having fwallowed fome ants in water which he drank greedily during the night, was attacked with burning thirft and heat, attended with a fenfation of acrimony and acute pain in the ftomach. Thefe firft fymptoms were fucceeded by a pretty violent cholic, and an alvine evacuation which lafted feveral days with violent gripings. This diforder continued four whole days.

E. *Of Refin-lac.*

20. WHAT is improperly called *gum-lac* in commerce is a refin of a reddifh brown colour, femi-tranfparent, dry and brittle, depofited upon branches, round which it forms a hive or heap of cells which contain the eggs of a fpecies of infect. It was formerly believed to proceed from a fpecies of ant; it is now known that i is a coccus whofe puncture produces, upon the young fhoot of the *ficus indica*, the *ficus religiofa*,

igiofa, and the *croton lachificum*, a refinous exudation. They diftinguifh the lac in grains, in fticks, and in plates, or fhell lac. The two firft are in the natural ftate: the laft is the refin melted and poured into plates.

21. It was from error that fome chemifts formerly compared lac to wax; its drynefs, its aromatic fmell when it is burnt, its folubility in alcohol, conftitute it a real refin; nay, it actually belongs to the vegetable fubftances. I fpeak of it here only, becaufe it is the conftant product of the puncture of an infect, and would not exift without this puncture.

22. There exifts in the lac a colouring matter which appears to proceed from the infect to the action of which its difcharge is owing, and the young of which are found inclofed in the cells. It was on account of this colouration, and of the cells deftined to lodge the young, of which this concretion is formed, that Geoffroy compared this refin to wax. It is afferted that this refin is employed in India for dyeing cloth, and in the Levant for dyeing the leather called Morocco-leather.

Its great ufe is in the preparation of fealing-wax, of which it forms the bafe. It enters into the compofition of the thick varnifhes of China and Japan, on which account they are called *laque*, or *vieux laque*.

Some ufe is made of it in medicine as an external tonic and a ftringent; it is an ingredient in the *Trochifques de Karabè*; in the powders and opiates

great force. The multiplied uſes for which it is employed are well known, as well as the abundance of this production, compared with its ſcarcity a century and a half ago.

25. The ſilk-worm, contains in a reſervoir ſituated near the anus, eſpecially in the ſtate of cryſalis, an acid liquor, which has been examined by Citizen Chauſſier. The moth diſcharges ſome drops of it, which redden blue paper. This inſect expreſſed, yields a juice which mixed with alcohol, precipitates a mucilage, an oil, and gelatinous matter, and leaves bombic acid in ſolution. By evaporating this ſolution we obtain an acid, pungent liquor, of an amber-yellow colour, which turns the blue colours red, and which forms particular ſalts with theſe baſes. Hitherto, neither the bombiates, nor the nature and compoſition of the bombic acid, have been examined. It is extracted alſo by infuſing the chryſalids in alcohol. It is deſtroyed by the action of fire; hence it is not obtained in the diſtillation of theſe cryſalids. An analogous acid exiſts in ſeveral caterpillars, in that of the willow, and in many inſects. But it is not known whether it be of the ſame nature with the bombic acid, and whether one or other reſembles or differs from the formic acid: it may be ſuſpected that they are all acetous acid.

G. *Of Cochineal.*

26. Cochineal is the body of the female of a hemipterous insect, which is produced, grows, is fecondated, attaches itself to and dies upon the leaf of a *nopal* called *cactus coccienelliffrus*, from which it draws the juice. Its body dries upon it, and is collected by the natives of South America, who particularly cultivate or take care of this insect. The wild cochineal, which is enveloped in an external spinning is distinguished from that which is cultivated and which loses this covering, at the same time acquiring a greater bulk and a richer colour; this production has long been considered as a seed. It is in Mexico that the cochineal is cultivated, and also spontaneously produced: its form, its structure, the number of its rings, all its characters in short, develope themselves when it is steeped for some time in water.

27. This production gives, by the action of fire, the same results as all the animal matters. Carbonate of ammonia, thick and fetid oil, carbonated and sulphurated hidrogen gas are extracted from it. Its colouring part has been particularly an object of attention, as it is from this that its great use in the art of dyeing arises. It gives a crimson violet colour to boiling water, which is rendered red and yellow by the acids; these frequently precipitate from it a

feeula of the fame or a darker colour. metallic folutions, added to its decoction general, form in it a coloured precipitate. muriate of tin gives a depofit of a beaut red, which is more abundant when tarta added to the decoction. Treated with alco the refidue of the evaporated decoction cochineal gives to it a very red colour, which the evaporation of the alcohol acquires form of a refin: this, as well as the dregs of extract not diffolved by the alcohol, yields products of an animal fubftance by diftillati The decoction of cochineal keeps withc putrefaction. The cochineal itfelf remai more than a century without its nature bei changed, in a dry place, according to the o fervation of Hellot, who employed fome whi had been kept a hundred and thirty yea The oxigenated muriatic acid turns the deco tion of this fubftance yellow; and we ma eftimate its goodnefs, by the proportion of th re-agent which we are obliged to employ i order to difcolour it.

28. Cochineal is the moft valuable and th moft beautiful of the red colouring matter which are employed in dying. The red, crim fon, poppy, orange, violet, and fcarlet dyes, ar prepared with it. The laft-mentioned colour particularly is produced by the addition of muriate of tin and of tartar to the decoction of cochineal. Its colouring part differs principally from that of madder by a greater folidity or

unalter-

unalterability: this is the reason why in separating the colour of the cochineal from water, by a substance which precipitates it, its primitive colour re-appears, little changed, though it had been turned yellow by the acids, whereas in the same case the colour of the madder retains a yellow or fawn-cast. Carmine is prepared from the cochineal, it is a kind of lac, precipitated from its decoction, mixed with alum by the alkalies, *autour* and *kouan* are mixed with it, in order by their yellow to render the too deep red of the cochineal lighter, and obtain the brilliant colour of the carmine. Cochineal is also used for colouring several alimentary and pharmaceutical preparations.

II. *Of Kermes.*

29. The kermes, *coccus infectorius*, is a kind of a violet, or dark red, or brilliant brown gall, proceeding from the female of a hemipterous insect, which fixes itself and dies upon the leaves of the green oak of Provence or of Italy. This female insect in dying and attaching itself, assumes the form of hemispherical cap, in which the figure of the primitive animals is lost. They separate these dry scales, which were for some time considered as tubercles or excrescences of the tree: they have also been considered as the seeds of the tree; whence the name of *kermes-grains, scarlet-*

 grains.

grains. The white down which ferves to attach this infect to the leaves, has fome characters analogous to thofe of caoutchouc, according to Citizen Chaptal. This infect is collected in the nights of May and June; the young and the eggs contained under the cafes of the female are fuffocated by macerating the kermes in vinegar or expofing it to its vapour. It is afterwards dried in the fun upon cloths; it acquires a red vinous colour in this operation. That of Galatia and Armenia, was formerly preferred: at prefent it is collected in Spain, in Portugal, and in the ci-devant Languedoc.

30. Kermes has all the properties of the animal matters; it gives the fame products by the action of fire. Its colouring matter, which forms its principal character and determines its employment is foluble in water and in alcohol. Thefe two folutions evaporated leave a highly coloured extract. When kermes is ufed in dying, alum and tartar are added. It gives a very lively cinnamon colour with the folution of tin; the alkalies, tarnifh its colour. The tinges which it produces upon wool have much lefs luftre than thofe of cochineal; but they have much more folidity, and we may remove fpots of greafe from them without altering the dye of the cloth. The blood-red of the ancient tapeftry proceeds from it. Its action is combined with madder for what is called *half-grained fcarlet*; the addition of muriate of tin turns the colour of

kermes

kermes yellow, for which reafon it is little or not at all employed by the dyers: on account of the folidity and unalterability of this colour, it is to be regretted that it is not more in ufe at prefent: in the Levant it is more employed.

In medicine, the kermes was ranked amongft the aftringents: it is an ingredient in the fyrup of coral and in the alkermes confection, to which it has given its name.

I. *Of Crab's Stones.*

31. THE crab's stones, which formerly were very improperly called *crab's eyes*, on account of their form, are concrete bodies, rounded and convex on one fide, compreffed, and as it were hollowed in on the other, two of which are found in the fides of the ftomach of this cruftaceous animal, at the period when his foftened body is difpofed to form the calcareous fhell which covers it. It is believed, with a fufficient degree of probability, that thefe concretions, which are found in the crab only at the period when it changes its fhell, proceed from a kind of metaftafis, which tranfports the calcareous matter from the exterior of their bodies to the interior; in fact they difappear in proportion as their external covering becomes folid, by abforbing, as it appears, the folid fubftance which was depofited upon the fides of

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the ftomach. Thefe ftones vary greatly in fize and are produced every year.

32. When the crab's ftones have been extracted, they are only dried in the air and the fun, and are afterwards fold for medicinal ufe: the druggifts pulverize them, wafh them, and triturate them with a little water; they afterwards form the pafte that is made of them into troches, which they dry in the air upon paper: this is what is called *prepared crab's ftones.* The water with which they are wafhed, and efpecially hot water, takes up from the crab's ftones a fmall quantity of gelatinous matter, which is mixed in them with the carbonate of lime. Thefe concrete bodies are converted into pure lime by the action of fire. Though we have no exact analyfis or very ftrict chemical examination of them, it is known that they are formed, at leaft for the greater part, of calcareous carbonate. The crab's ftones are entirely foluble in the weakeft acids. Their medicinal properties are confined to their abforbent or ant acid quality; and it is without reafon that they have been ranked amongft the aperient, diuretic, and cordial remedies.

BIBLIOTHECA BODLEIANA

K. *Of the Lumbrici.*

33. THE earth-worm, *lumbricus terreftris,* the moft common of all the animals of the fame order, and which inhabits the fuperficial ftrata of the earth, from whence great numbers

of

of them come out during rain, is alfo the only one that is employed for certain ufes, though at prefent much lefs confidence is placed in it, as a medicinal fubftance, than formerly. Although no true analyfis of the earth-worm has been made, we neverthelefs know, that by fire the fame products are obtained from it, as from all other animal matters. Several authors on the Materia Medica have even grounded the properties which have been attributed to them upon the large quantity of volatile falt and oil which the worms furnifh by the action of fire.

They have been ranked amongft the fudorifics and diuretics, they have been recommended in the calculous affections: they were prefcribed dried, and pulverized; they have been efpecially employed for the preparation of external remedies, particularly when boiled with oil, for the purpofes of refolving and ftrengthening, in fciatic pains and rheumatifm. Some authors have alfo defcribed them as external ftimulants in paralyfis. The lumbrici are hardly ufed at all in modern pharmacy.

Article XXXIV.

Of fome Matters peculiar to the Zoophytes.

1. THE zoophytes, the laft in the fcale of animated beings, on account of the fimplicity of their ftructure, frequently refemble branches and vegetable ramification, on which account they

have

have received the name which they bear. Notwithstanding the number of the ſpecies and the immenſe quantity of the individuals which cover a great part of the bottom of the ſeas, they furniſh very few uſeful products to medicine or the arts. I know only four ſubſtances belonging to them which deſerve a particular examination, viz. the coralline, the coral, the madrepore, and the ſponge.

A. *Of the Coralline.*

THE coraline is a kind of habitation of polypi, hitherto unknown, and compoſed of articulations covered with a calcareous integument, the corneous axis of which ſends out fibres which traverſe the cretaceous ſubſtance and go as far as its ſurface. Its articulations are oval and have their points downwards; its branches diſperſed twice in the form of the plumes of feathers. are cloſe to each other, and reſemble a very tufted ſtony buſh. There are immenſe quantities of corallines upon the coaſts of the ſea; they vary in their colours, which are white, grey, greeniſh and reddiſh; they are diſtinguiſhed by their form and their cretaceous nature from the coralline of Corſica, which is only a ſpecies of conferva, or of filamentous fucus, without articulations, without calcareous integument, and which forms with boiling water, in which a great part of it diſſolves, a viſcous jelly.

3. Coralline

3. Coralline has a faline, acrid, and difagreeable tafte, a very fenfible flefhy or marfh fmell; it crackles between the teeth; it crumbles between the fingers, and readily fhows under its calcareous powder its interior corneous ftalk. It diffolves in the acids with effervefcence, and leaves foftened and dilated gelatinous filaments. Water extracts from it by ebullition only a fmall quantity of gelatinous matter; in the retort, however, it gives very fenfible products of an animal fubftance, and efpecially carbonate of ammonia and fetid oil. It is reckoned amongft the anthelminthics and aftringents; but it enjoys both thefe properties only in a very feeble degree: it is an ingredient in the anthelminthic powder. Modern authors clafs it among the abforbents.

A. Of Coral.

4. Coral, *corallium officinalis, ifis nobilis* of Linnæus, a kind of zoophyte well characterized by its folid, ftony, red, rofe-coloured, or white axis, ftriated at its furface, covered with a bark of an aurora red colour, having cavities from which proceed polypi with eight dentated tentacula, was formerly very much efteemed and rated at a high price on account of its fine colour and its denfe texture, fufceptible of a beautiful polifh. Coral is fifhed for upon many maritime fhoals, and under the projections of rocks, efpecially by means of laths, or bars of iron placed crofs-wife, which detach and raife

raiſe the branches of this production. The corals, of leaſt value are thoſe in which the polypuſes no longer exiſt, and which have ſerved ſeveral other marine animals to fix themſelves upon. The living cora is ſtripped of its fleſhy bark, and its ſtrong axis laid bare.

5. The fine ſmooth poliſh which may be given to coral, the beautiful red, carnation, or roſe-colour which it preſents, the ſolidity of its texture and its inalterability by the air, rendered it formerly one of the material the moſt frequently employed in the fabrication of jewellery. On account of the advantageous ideas which were at the ſame time conceived of its virtues, it was cut into amulets, into polyhedrons, into olives, and into ſpherical and cylindrical forms, it was made into rings, croſſes, bracelets, neck-laces, &c.

Since its analyſis has proved that it contains only carbonate of lime, a little iron, and a ſmall quantity of gelatinous matter, it has only been ranked amongſt the abſorbent matters. Great confidence was formerly placed in the combination of the acetous acid or lemon juice with coral, and in the ſalt reſulting from this combination. It was adminiſtered as an antiſpaſmodic, ſedative, aſperient and diſſolvent. This is nothing more than the calcareous acetite or citrate. It was made an ingredient in the powder of Guttete, the confection of Kermes, the troches of Karabé.

At

At prefent it is employed only in the preparation of powders and opiates for the teeth.

We muft not confound with the real coral what is called *black coral,* which is an *antipathe* the axis of which, formed of a corneous fubftance, dries in the air, and receives a very beautiful polifh.

C. *Of the Madrepore.*

6. THE name of madrepore is given to all the fpecies of the habitations of polypi, of a calcareous nature, upon which the cavities in which the animals are lodged are difpofed in ftellated forms. They are diftinguifhed by their form into fungites, meandrites, aftroites, porites, millepores, and madrepores, properly fo called, which are characterized amongft all the reft by their branched ftalks. Thefe laft are fometimes, though improperly, denominated *white coral.* The furface of thefe apparently ftony bodies is entirely covered with a foft and mucous membrane, charged with living tubercles, which are real polypi. Thefe fpecies of animal productions are more efpecially called *lithophytes,* on account of their folid and ftony nature, connected with their form of vegetables or of divifions frequently ramified.

7. The madrepores feparated from the animated mucous layer which covers them, and reduced to the folid bafe deprived of all the animals which it fupported, are only carbonate of lime

in an almoſt pure ſtate. However, when the calcined, they emit an animal ſmell; they be black and are converted into coal on ac of the ſmall quantity of animal matter they contain between their interſtices; but are ſoon reduced into lime, of which they afford a very good kind for building. the madrepores are treated with the acids, are ſoon attacked with effervefcence; carbonic acid is diſengaged, and they are entirely diſſolved; they ſcarcely leave a few of very fine lamellæ or detached flakes o latinous matter, nearly like thoſe obſerv the calculous concretions of phoſphate of li phoſphate of magneſia. Theſe chemical perties prove that the madrepores ought conſidered as ſimple abſorbents.

D. *Of Sponge.*

8. SPONGE, the laſt degree of anima which, without any organ, preſents only latinous integument, the tremulous moti ſlight contraction of which is the only ſi life that can be remarked in it, is compoſ a fibrous, flexible texture, full of pores, a cells communicating with each other, ca of being reduced by preſſure to a very pace, of afterwards returning to its ori volume, abſorbing water by a number o pillary tubes, acquiring by this abſorpt

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emarkable foftnefs and flexibility, and becoming dry and harfh when deprived of water.

9. Sponge, after the deftruction of the animal jelly which covers it, and after multiplied wafhings, prefents only an elaftic, infipid, inodorous, fibrous texture, the nature of which feems to approach to that of a prepared fkin; its colour is brown or fawn. It furnifhes, by diftillation, the ordinary products of animal fubftances, carbonate of ammonia, a thick and fetid oil; and it leaves a pretty denfe coal, from which muriate of foda and phofphate of lime are extracted. It diffolves with difficulty in the alkaline leys, and the acids alter it after the manner of the animal fubftances, the fulphuric blackens it, and reduces it to coal, the nitric turns it yellow and reduces it into oxalic acid and fat matter; it is unalterable by air and water.

10. Befides the economical ufes to which fponges are applied in houfes for a number of objects of cleanlinefs, from the coarfeft and moft voluminous, which ferve for rubbing walls, floors, carriages, &c. to thofe of the fineft texture which are prepared for cleanfing the fkin; it is ufeful in furgery for forming kinds of tents and doffils employed for enlarging fiftulas, keeping their cavities open, and abforbing their moifture, in medicine burnt fponge reduced to afhes has been much recommended for difcuffing bronchoceles or goitres, or diffipating fcrophulous tumors, &c.

FOURTH ORDER OF FACTS.

Of the Chemical Phenomena which living Animals present, or Applications of Chemiſtry to Animal Phyſiology.

Article I.

Of the Exiſtence and the Kind of the Chemical Phenomena which take place in the Bodies of living Animals.

1. IN a great number of the preceding articles, I have had frequent occaſion to ſhow that there preſent themſelves in the middle of the body of animals, and during the enjoyment of their life, real chemical phenomena; what I have ſaid of them, both in the general expoſition of the chemical properties of the animal ſubſtances, and in the particular hiſtory of each of theſe ſubſtances, is however not ſufficient to anſwer the end which I have propoſed to myſelf. I muſt now deduce from all the facts comprehended in this eighth ſection the general reſults which are their true corollaries: I muſt bring under one point of view and render more ſtriking by their concentration, all the truths ſcattered in this part of my work: this is what I propoſe to do in this laſt order of facts.

2 It

[t muſt firſt be aſcertained that there actual-
iſt in the bodies of living animals, true che-
phenomena, product and changes proceed-
·om the intimate attraction which governs
ifferent particles of which the organic tex-
of animals is compoſed, that animal life
ſts neither in the purely mechanical play
ıe organs nor excluſively in a particular
r, a vital principle independent of any
natural force, which ſeems to have been
tted in a celebrated ſchool, after the ex-
e of ſome illuſtrious phyſicians of the laſt
only in order to ſhow the uncertainty and
iency of the mechanical phyſiology which
ɔeen ſo much abuſed. We muſt explain
kind of chemical phenomena animal life
ſts of, how they differ from thoſe which are
ved amongſt the foſſils, or even in the ani-
matters themſelves deprived of life, what
heir peculiar characters, and how we may
to arrive at the developement of their
:rious mechaniſm.

Two general modes of the manner of exiſt-
of living animals appear to me to be proper
roving that there take place in them a very
rkable chemical action; that life conſiſts
great meaſure in the products, reſulting from
: actions, and that in order to know its na-
as far as it can be known by the human
l, it is of indiſpenſable neceſſity to ſubmit
actions to the moſt attentive examination.
nimal, at the moment when the germ
which

which has given birth to it, has received the firſt vital movement, continues to exiſt only by the ſucceſſive addition of matters extraneous to its own body. Theſe matters, received into particular cavities, aſſimilate themſelves to its own ſubſtance, become gradually integrant parts of its organs, augment them in weight and extent, aſſuming exactly their nature. Now the vegetable matter which experiences this aſſimilation in the animated body, actually changes its intimate nature, and becomes a new chemical compound, different from what it was at firſt. It is therefore very evident, that this cannot take place without a variation in its combination, without the loſs or acquiſition of ſome principle, or change of proportion in thoſe which originally conſtituted it. This is the inference which muſt neceſſarily be drawn from the compariſon eſtabliſhed between the vegetable and the animal body.

4. If to this firſt mode, which cannot exiſt without chemical actions, we add what I here reckon as a ſecond mode of the exerciſe of life, which proves that of theſe actions, the obſervation of the phenomena which continually accompany the functions of living animals, there cannot remain any doubt reſpecting my preſent object. In fact, how many phenomena, really chemical, have we not occaſion to obſerve in the bodies of living animals. In all their parts, liquids become ſolid and concrete, whilſt ſolids melt and diſſolve; in

in all of them caloric is developed and propa gated, which keeps matters conftantly liquid: in fome cafes, concrete fubftances are foftened and liquefied by a real folution; in others faline cryftals, and coagulated flakes are depofited, and attach themfelves to one another. In the midft of expanfive cavities and refervoirs, elaftic fluids are formed and dilate themfelves; in tubes curved in innumerable ways, mucous fluids thicken or become liquid, evaporate or condenfe; infipid and colourlefs bodies acquire colour and tafte; oily bodies are produced, or become faponified; precipitates are formed or difappear; falts change their bafes, or decompofe each other; other falts are conftituted; acids are compofed; fome alkaline bafes even feem to be produced or formed in a direct way, &c.

5. Thefe effects, refpecting the exiftence of which, no doubt can remain in the minds of thofe who obferve without prejudice, and who are able to diftinguifh the phenomena which nature prefents to every eye, in their general refults, produce the change of the vegetable into animal matter; a greater complication in the compofition, and an augmentation in the proportion of the azote, or a fixation of this principle; a fimilar augmentation in the hidrogen; a formation of ammonia, and of fat oil, or a great difpofition to the production of thefe two bodies; a formation of phofphoric falts; a volatilization of the water, of the carbon and of the hidrogen redundant in the animal compofition in

general; a frequent difengagement of carbon acid gas, or carbonated and fulphurated h drogen gas; facts and circumftances whi have already been often indicated in the articl relating to all the animal compounds which ha hitherto been confidered.

6. But it muft alfo be remarked, that t chemical actions, or phenomena which ta place in the bodies of living animals, are n always of the fame kind with thofe to whic the animal matters deprived of life are fubjected that nature has frequently impofed upon he felf other laws, in this refpect, and that it the more effential to appreciate this diffe ence well, as it has long been the fubject of difcuffion, which has greatly impeded the pr grefs of animal chemiftry. Phyficians ha pretended that the chemical phenomena obferve in the dead matters, have no relation with tho of life; that the conclufions drawn from t former, which for a long time were exclufive attended to, could not in any wife be appli to the latter, and that it was impoffible to d rive any light from them in phyfiological e planations. Though this affertion is not fo i tirely true as has been pretended, it neverthel merits to be examined with much attentio fince it has deterred ingenious minds fro the cultivation of animal chemiftry, and h brought its applications to phyfiology, int much difrepute.

7. If we inquire impartially what is the cau of the difference between the chemiftry of liv

in

ing animals, and that of the dead animal ſubſtances, we immediately perceive, that the one being intirely out of the reach of our inſtruments and our methods of analyſis, it is only by the obſervation of the natural products, that it can be poſſible for us to arrive at their cauſes and reſults; the other, on the contrary, that which the chemiſt exerciſes upon the animal matters deſtitute of the power of life, is entirely at his diſpoſition; he acts upon theſe matters with means, with inſtruments, and with re-agents of much greater energy, and which nature does not employ; they are beſides in a different condition from the living matters; they have loſt their heat, their motion, their communications with the animated, living, irritable, and ſenſible organs. Every thing in the chemical art is violent, very active, decompoſing, annihilating; the analyſis is ſpeedily carried to its extreme, to its *maximum*; the ſeparation of the conſtituent elements is always inſtantaneous; the decompoſition is rapidly completed. In nature, the equilibrium of compoſition is more ſtable, the chemical changes take place only in a progreſſive manner, and, as it were, at their *minimum*. Slight variations in the proportions are ſufficient for the ſucceſſive tranſitions, and the regular converſion of the matters into one another.

8. Hence it is, that the liquids and organic compounds which conſtitute the bodies of animals during life, tend to preſerve their

ſtate, to remain in their primitive order of combination, and are altered and changed only in an imperceptible manner; they maintain their accuſtomed temperature and conſiſtence; loſe only ſome of their principles, and theſe gradually; recover what they have loſt in order to continue in the ſame ſtate; and ſupport this permanency, this conſtancy of nature in the different regions of the body, in which they are ſituated, or through which they paſs. Upon this depends that incorruptibility, that freſhneſs, that oppoſition and reſiſtance to the ſeptic decompoſition, which forms ſo decided a character of the living animal bodies, and ſo ſtriking a contraſt with the dead animal matters. And in fact, ſcarce has an animal compound ceaſed to participate of the vital movement, when it becomes no leſs changeable and alterable, than it was permanent and ſtable under the empire of life; its colour fades, its conſiſtence changes, a ſmell, at firſt faint, and afterwards diſguſting, exhales from it; fetid elaſtic fluids are diſcharged from it; an ichorous ſanies is diſcharged from it. Its texture becomes relaxed, and its putrid nature atteſts the new alterations, and the rapid decompoſition which its elements obey. Thus death is as powerful a cauſe of corruption, as life is of preſervation.

9. But ought this difference, great and remarkable as it is, to prevent our referring or comparing the phenomena which chemiſts obſerve in the dead animal matters, with thoſe

which

which exist in the same matters whilst living; and may it not become a subject of useful studies or observations? May it not furnish the means of appreciating what takes place in the one, according to what is found in the other? Must we renounce the idea of describing and determining with precision, what takes place in the dead matters, because the same thing does not happen in the living; and can the one of these results be an impediment to the knowledge of the other? I do not think that this conclusion is to be drawn; on the contrary, it is my opinion, that we ought to avail ourselves of the chemical effects which are perceived in the dead animal matters, in order to appreciate what happens to these matters whilst living; and, that we cannot comprehend the changes which the latter undergo, unless we have begun to determine with precision, the changes of which the first are susceptible.

10. Besides, though there really exist differences between the chemical results that are observed in the bodies of living animals, and the products which are obtained from their dead bodies treated by the art, it cannot be denied that there also exist some analogous effects in the two kinds of substances. These differences have certain limits; they take place only to a certain extent, or only with respect to some properties. It is also to be remarked, that when we enunciate the chemical properties of the animal

mal matters deprived of life; when we rank in this clafs the effects which they give by the re-agents which are mixed with them, we do not pretend that thefe effects would be produced exactly in the fame manner upon thefe matters if living. No modern chemift is guilty of this error; they all know, for example, that a high temperature does not act upon the parts or the liquids of living animals, as it acts upon thofe parts or thofe liquids after their death; that their organs and their fluids refift the action of the alkalies and the acids, as well as that of heat or cold, by the vital power which animates them. But they alfo know, that this refiftance to the action of the chemical agents, is limited and acknowledges a certain boundary; that if we weaken the energy of thofe agents, even in their effect upon the dead animal matters, it becomes inert as upon the living, or, that by rendering it very ftrong in thefe, they then act as upon the dead matters. Finally, they do not apply thefe refults immediately, and in all cafes, to the living matters, but ufe them only as agents for afcertaining the compofition of thefe matters.

11. Such are the general reflections, which ought to precede the applications of chemical knowledge to animal phyfiology; they are equally calculated to deftroy the prejudices which have been propagated againft the utility of thefe applications, and the abufes which have

ave been made of chemiſtry in the explanation f the phenomena of phyſiology. I was obliged o unite them here as a ſort of introduction to he animal chemiſtry, becauſe they form the rue foundation of the reaſonings, which are at reſent employed upon this branch of chemiſtry; ecauſe they ought to direct our conceptions f the chemical phenomena which take place n phyſiology; and finally, becauſe they prove hat we cannot flatter ourſelves with the hope of eing able to comprehend what is permitted to an to attain in the mechaniſm of the animal conomy, without the knowledge of the chemical properties of the fluids and ſolids which onſtitute it. In our preſent conſideration of ach function of the living animal bodies, the pplications which I ſhall point out will develope heſe fundamental truths, and afford multiplied roofs of the indiſpenſable influence, which the reſent ſtate of chemiſtry muſt have upon animal phyſiology.

Article II.

Of the Chemical Phenomena which ta in Refpiration.

1. RESPIRATION, which, in the an which it is moft complete, is exercife veficular lungs, and is compofed of movements of infpiration and expiratio of the functions the moft effential to without which it could not exift; it is of thofe which have received the great from the modern improvements in c knowledge. The hypothefes that had b gined for determining its ufes, from . down to the prefent time, have been ful truths, which chemiftry alone could have been fubftituted in their place; tl originated from the accurate knowle has been acquired refpecting the air, means of analyzing this fluid, which tl matic doctrine alone could furnifh.

2. It has been by experiments upon th upon refpiration itfelf, upon the air, to its entrance, and after its exit from cus, that the truths of which I fpeak ha difcovered. Cygna, Prieftley, Crawfo milton, and efpecially Lavoifier and

have successively instituted the researches which have led to their discovery. Venous and arterial blood exposed to different gases; animals inclosed in bell-glasses, with air in different circumstances; the examination of the air at different periods of these experiments; man himself, exposed with the aid of ingenious machines to the action of the air and various aërial mixtures: such are the principal means that have been employed for resolving the problem of respiration: and though there is still some doubt and uncertainty respecting the results of these experiments, they have, however, thrown upon this important function, a light which it could not derive from all the ancient data of physiology, without the instruments and means of modern chemistry.

3. It has been found that the air which enters the lungs is altered, and that the proportion of oxigen gas progressively diminishes in it; that animals, in a given time, do not consume more of the oxigen gas requisite to the support of their life, whether they be made to respire it alone, or whether it be mixed with azotic gas, in different proportions, provided it amount to at least a tenth of the mixture; that carbonic acid gas is formed during inspiration; that there is also produced a certain quantity of water, independent of that which is discharged immediately, and ready formed from the blood by the pulmonary transpiration; that when in respiration, by an external addition of this gas,

gas, the proportion of the carbonic acid amounts to $\frac{1}{4}$ of the air, the exercise of this function is accompanied with great inconvenience; that the quantity of azotic gas is neither greater nor smaller, but remains exactly the same in the air expired, as it was in the air inspired, and that this gas does not influence respiration: that the consumption of air in respiration increases after a meal, in lifting burthens, in performing any exercise, especially in running.

4. From these first effects which have been accurately determined by experiment, modern philosophers have concluded, that the oxigen gas is that principle of the air, which is useful in respiration, that it is there subservient to a combustion, that it burns carbonated hidrogen separated from the venous blood, that thus carbonic acid gas and water are formed; or rather, that the oxigen is absorbed by the blood and its place in the pulmonary air, supplied by carbonic acid and water; which, indeed, renders the problem undetermined. But if we remark that the venous blood exposed to oxigen gas, converts it into carbonic acid; that the combustion of the carbonated hidrogen in oxigen gas takes place in a multitude of vegetable or animal organic matters, even at very low temperatures, it will no longer appear doubtful, that this compound, which has become superabundant by the effect of the circulation, really burns in the lungs, and that the oxigen gas of ths air combines in the

pulmonary

pulmonary veficles with thofe two principles, the hidrogen and the carbon, fo as to form water and carbonic acid, which did not previoufly exift, either in the blood or in the air.

5. Though this converfion of the carbonated hidrogen of the blood, and this converfion of the atmofpheric oxigen into water and carbonic acid, be the principal phenomena of refpiration, there is no reafon to doubt that a fmall portion of this vital fluid, is at the fame time abforbed by the blood, and contributes, with the lofs or the difengagement of the carbonated hidrogen, to change the nature and properties of this liquid. Thus, the undetermined problem of which I have fpoken, is not really fuch, except with relation to the proportion of atmofpheric oxigen abforbed, and to that of the fame oxigen employed for burning the hidrogen and the carbon, for forming the water and the carbonic acid. It is probable that this proportion, this partition of the abforbed or burning oxigen, varies according to many circumftances, which fhall be hereafter appreciated, and the knowledge of which, will give greater precifion to that of the mechanifm and ufes of refpiration.

6. From the combuftion of the carbonated hidrogen, the principal phenomenon effected by the air during infpiration, refult two important effects refpecting the nature of the blood; and in thefe two effects confifts one of the moft important ufes of refpiration. The blood

blood is deprived of a principle with which it was furcharged, and which rendered it unfit for the purpofes of life; its nature is changed, and its compofition renovated; fo that it becomes fufceptible of fullfiling the functions for which it is deftined, as I fhall fhow in the article concerning the circulation. On the other hand, the oxigen gas cannot burn the hidrogen and carbon of the blood, without being condenfed, without lofing or fuffering a portion of the caloric which kept it diffolved to be difengaged, in the ftate of an elaftic fluid; and this caloric having become free, feizes upon the blood, and elevates its temperature. That portion, alfo, of this gas, which is condenfed in the blood, developes by its condenfation, a portion of its caloric, which contributes to heat this liquid.

7. Thus, according to the firft ideas of Crawford and Lavoifier, one of the principal utilities of refpiration, and one of the moft remarkable ufes of the air received into the lungs, is the production of the animal heat: by the aid of the combuftion which is effected in them, the blood becomes heated and maintained at the temperature which characterizes this liquid. The chemical explanation of what takes place in refpiration, is entirely comprehended in the following propofition: The attraction of the carbonated hidrogen of the blood, and of the entire blood, for the oxigen, is ftronger than the united attractions of the caloric for the oxigen,

oxigen, and of the carbonated hidrogen for the blood; the atmofpheric oxigen gas is decompofed; its bafe unites with the hidrogen, and with the carbon, or is condenfed in the blood, whilft its difengaged caloric combines with this liquid. The blood befides abforbs the caloric the more fpeedily, as in lofing its carbonated hidrogen, its capacity for caloric is augmented, as fhall be fhown in the fubfequent article.

8. Thefe effects of refpiration agree fo well with the known phenomena of this function, that the comparifon and combination of thefe phenomena give additional ftrength to the theory furnifhed by the modern experiments. The heat of animals is conftant as long as their refpiration follows the fame laws. When the infpirations become more confiderable, and more frequent by exercife, running, finging, exertion, the heat increafes with the refpiratory movements. In morbid debilities, when the fpafm diminifhes, and retards the infpirations, at the approaches of death, the body becomes cold in proportion as the refpiration is concentrated or extinguifhed. The animals which refpire little, or which do not refpire air, like tortoifes, frogs, ferpents, fifhes, have blood not fenfibly heated above the temperature of the medium which they inhabit, on which account they are called *cold-blooded animals*.

ARTICLE

ARTICLE III.

Of the Chemical Phenomena which take place in the Circuldtion.

1. THE caufe and the effects of the circulation of the blood were equally unknown, previous to the new chemical difcoveries; an obfcurity pervaded this function, which appeared the more profound, and the more hopelefs, as the organs by which it is carried on were very well known: every thing was therefore completed for anatomy, whilft every thing remained to be done for phyfiology. An equal ignorance prevailed, both of what produced the motion of the heart; of what diftinguifhed the venous from the arterial blood, which was known to be different from it; of the changes which this liquor underwent in the arterial and venous circulation; of what happened to it by its mixture with the chyle, and the caufe of the great influence which it has upon life, as well as upon all the other functions of the animal economy. Every thing appertaining to this primitive function, was a myftery that had been confidered impenetrable. By chemiftry alone, this part of phyfiology, which ftill appeared hopelefs, began to acquire fome real illuftration a few years ago.

2. It

2. It was in ſtudying the phenomena of reſpiration, that modern chemiſtry diſcovered ſeveral of thoſe of the circulation which had eſcaped the reſearches of phyſiologiſts; it firſt occupied itſelf with the difference between the venous blood arrived at the cavities of the right ſide of the heart, and the arterial blood which comes from the lungs and enters the left cavities of the heart, a difference, reſpecting which, it might perhaps be permitted to Haller to ſtart ſome doubt as an anatomiſt, notwithſtanding the data collected by Galen, Lower, Schreiber, Willis, Swammerdam, Duverney, Verheyen, Schwenke, Lanciſi, Mayow, Pitcairn, Severinus, Helvetius, Michelotti; a difference, which is not the leſs real, on account of its being ſometimes not apparent to the eye, and which might be deduced from the mere nature of things, and the ſlighteſt conſideration of the functions and organs. The brilliant red colour of the arterior blood, the violet, and almoſt black hue of the venous, the more elevated temperature, the greater lightneſs, the frothy ſtate of the firſt, compared with theſe properties conſidered in the ſecond, ſhowed that this liquor acquired new characters in the lungs, and by the influence of the air; that it loſt carbonated hidrogen, acquired caloric and oxigen, was actually changed in its nature, and in a manner conſtituted afreſh for a new life.

3. Theſe new properties, this change of nature, this loſs of carbonated hidrogen replaced

by

by caloric and oxigen, give a revivified blood, the power of irritating the heart, and exciting its contraction, by which the vital movement is perpetuated. All these defects depend so much upon the air containing oxigen, that without its presence respiration is stopped, the blood remains black and venous, the heart ceases to move, and even loses its irritable power, so that life cannot again be recalled, as we see in prolonged asphyxias. Crawford, by his ingenious experiments, has given confirmation and precision to this fine result of the modern discoveries; he has proved that the capacity of the arterial blood for caloric, is to that of the venous, as 11,5 to 10, and that in proportion as the latter is, as it were, revivified in the lungs, and loses its carbonated hidrogen, it acquires the property of more easily absorbing the matter of heat.

4. The effect the blood so manifestly produces upon the heart, that power which it excites in it, and at the same time imparts to it, of contracting itself, and propelling this liquid by its left ventricle, even to the extremities of the arteries, whilst it can scarce give to the thinner coats of the right ventricle, the power of sending it to the little distant pulmonary ramifications, that effect it also produces upon all the muscular fibres of the different regions. It conveys, together with heat and life, the stimulating and existing force into all the muscles. Intimately united with the chyle, which

which reftores to it, as it is poured into it, near to the bafe of the heart, the matter which it has loft in circulating, it animalizes this product of digeftion, which, on its part, neutralizes the too far advanced animalization of the blood; it mixes and combines intimately with it, it affociates with itfelf a new proportion of principles, deftined to fupply the place of what efcapes from it every where in all the organs through which it flows. In this combination of the blood with the chyle, it appears that the converfion of the faturated and white phofphate of iron, which the latter contains, into fuperoxigenated red phofphate of iron proceeds from the fimultaneous double effect of the blood, of the foda, and of the oxigen of the air; the firft as carrying off a portion of phofphoric acid, and infulating an excefs of iron; the fecond as fuperoxidating and reddening the latter: fo that it is by this chemical mechanifm that the coloration of the blood is produced and exalted. Thus the relation of the co-operation of the effects of the circulation and the refpiration upon the blood, conftitute, in the point of view of the compofition of this liquid, and by the different modifications which I have defcribed, that refult hitherto fo incomprehenfible, which the phyfiologifts have defignated by the name of *hæmatofis*.

5. Phenomena, in fome fort the reverfe, take place in the act of the circulation itfelf, and efpecially at the extremities of the arterial ramifications, at the boundaries of the circulating

 fyftem,

fyftem, and in all the places, and all the furfaces where thefe extreme ramifications terminate in the extremities of the venous branches. The arterial blood every where diftributes heat, irritation, and life; it moreover tranfmits the albuminous or fibrous nutritive matter; it fuffers a portion of water to exhale from its own fubftance; and gradually becomes furcharged with carbon and hidrogen. By this change of nature, a part of its fpecific caloric is evaporated; in the fame proportion it lofes its vital faculties; it dies in fome fort, or at leaft becomes incapable of propagating life in the organs. The oxigen, more intimately adherent, and combined with its elements, giving them the concrefcibility and plafticity which conftitute its reparatory and nutritive quality, feparates from it with the fluids which depofit themfelves in the organs, or which efcape into the abforbent fyftem; modified in its compofition, deprived in part of its principles, become old and weakened in its vivifying powers, it is neceffary that it fhould return to the centre of the refpiration and circulation, to the confluence of the reparative chyle, in order to refume all its original properties, and to recover by the effects which I have defcribed, the equilibrium of combination, of aëration, of oxidation, and of temperature, which conftitute it arterial blood.

ARTICLE

Article IV.

Chemical Phenomena which take place in Digestion.

IGESTION, the function by which the s received into the stomach are con- nto chyle destined to repair and renovate od, presents so considerable a series of il phenomena, that it appears to belong to the province of this science, and cannot be better conceived or better ed, than according to the principles mistry. Accordingly, it is of all the functions, that with which the chemists ost occupied themselves, that which they bjected to the most numerous expe- , and for the theory of which they have the most results. And in fact, since it consists in the appropriation of the ary substances, and in changes of nature a kind, that these substances become ble of replacing the portion of the and of the organs themselves which is itly destroyed by the vital movements, ossible to consider it as any other than a emical operation.

he aliments placed in the mouth, are first and mixed with the saliva; the division

which they receive by the action of the teeth, introduces into them at all points, both the salival juices and the air, which this juice is so susceptible of retaining, as is proved by its frothy property. From this attenuation, and this mixture result in the alimentary bole, a disposition to soften, to dissolve, and already to approach to the nature of alimentary matter. In deglutition, and along the course of the œsophagus through which this bole passes, becomes penetrated with more animalized liquid with the juice of the œsophagus which always gives it the character of animalization. There are even animals, especially among the birds and the reptiles, in which the digestion of the aliments commences in the œsophagus: this case, however, is only observed in those species which have no organs of mastication, and which swallow their prey without dividing it. We frequently find in serpents, entire animals that that have not yet descended into the stomach, and that are already greatly softened in that part of the œsophagus which contains them.

3. It is in the stomach that real digestion takes place. The experiments of Reaumur and Spallanzani have incontrovertibly proved, that the aliments are there dissolved by the gastric juice; that this juice has a very great solvent energy which acts upon all the organic matters, even the hardest, such as the horns and the bones; that the solution of the aliments which result from it, reduces them in some

hours,

hours, three or four at lateſt, into a kind of ſemi-liquid homogeneous bouillie, ſometimes ſlightly acid, moſt frequently ſweet, and almoſt without taſte, of a grey colour, and which is called *chyme.* It is known that the preſſure of the muſcular ſtomachs, the heat which conſtantly reſides in them, their proper motion, or that of the contiguous parts, are merely auxiliary circumſtances, which may indeed favour and accelerate the ſolution or the digeſtion of the aliments, but which are not capable of producing it of themſelves. It is alſo known, according to the ſame experiments, that the gaſtric juice, is ſo antiſeptic in its nature, that it preſerves the animal matters that are immerſed in it for a long time from every alteration, and that it has been employed with ſucceſs as a topical anti-putreſcent: it not only prevents all fermentation of the aliments in the ſtomach, but alſo corrects and deſtroys the firſt putrid alterations which exiſt in the animal nutriment.

4. Though nothing has been found by the analyſis of the gaſtric juice, that can ſerve to explain, *a priori,* the remarkable effects which it produces in the digeſtion of the aliments; though the phoſphates, the animal mucilage the muriates, the free acid which it commonly contains, are not ſufficient to account for its properties, it is acknowledged that theſe are not only very energetic, as I have ſaid, but

even

even conftantly acting; that they exert their powers at all times, and in all the circumftances of life, and even fome hours after death; even the coats of the ftomach themfelves are not exempted from their diffolvent power. The celebrated Hunter has often found the ftomach rendered very thin, worn, and almoft perforated, in the parts where this juice had accumulated, and efpecially after long fafting, and in the bodies of perfons who had died in confequence of long protracted difeafes.

5. The digefted aliments, reduced to bouillie, united with the gaftric juice which has penetrated and diffolved them, arrived, with the aid of the natural movement which carries them from the cardia to the pylorus in the cavity of the firft inteftine, the duodenum, there meet with the pancreatic juice of the bile, which appears to me to act upon the chymous mafs, in a manner that has hitherto been miftaken by the phyfiologifts. It has been faid, that the bile, like foap, ferves to mix the alimentary oils and fats with water, and to reduce the whole to the ftate of a kind of emulfive liquor, which is called *chyle*. This cannot be its ufe, as there are fo many aliments that contain neither fat nor oil, and fo many animals that never take any fuch fubftance amongft their nutriment. It appears to me that the bile, united with the pancreatic juice, effects a real precipitation of the chymous fubftance; that it is itfelf

itſelf decompoſed in decompoſing the latter; that this decompoſition conſiſts in the ſeparation of the ſweet, white, milky, chylous liquor, which retains, with the moſt fluid part of the digeſted aliment, the alkaline and ſaline ſubſtance of the bile; and in a concentration of the thickeſt and leaſt digeſted portion, mixed with the colouring and oily part of the bile, forming the matter that is to become excrement.

6. By the truly chemical mechaniſm, the fat portion of the bile flows, and the too great redundance of hidrogenated animal matter is evacuated at the ſame time with the groſſer, the the more ſolid and the leaſt digeſted part of the aliments. The maſs thus precipitated or decompoſed, paſſes ſlowly through the inteſtinal canal, by the periſtaltic motion natural to this viſcus. In its paſſage it is preſſed by the ſucceſſive contraction of the muſcular rings and fibres of the inteſtines; this preſſure ſqueezes out from it the chylous liquid, which is taken up by the abſorbent and chyliferous veſſels; the maſs, deprived, through all the length of the ſmall inteſtines, of this fluid and mild part, is gradually exhauſted of it, acquires more conſiſtence and ſolidity, combines more intimately with the oily and colouring matter of the bile, becomes more or leſs powerfully altered, acquires a darker colour, and dries more and more in the large inteſtines, aſſumes the character of excrement, arrives at length at the rectum, the ſides

ſides of which it ſtimulates in ſuch a manner, as to produce the ſenſation which ſolicits its expulſion.

7. When this function is exerciſed in all its force, and unimparied, no elaſtic fluid is diſengaged in the ſtomach, and the firſt inteſtines; carbonic acid is formed only towards the loweſt regions of the inteſtinal tube, and at the period when having deſcended into this part of the canal, the reſidue of the aliments already converted into real excrement, begins to experience, by its detention and heat, the firſt movements of the ſpontaneous and putrid decompoſition of which it is ſuſceptible. The gas which is developed in the ſtomach, the wind, the carbonated and ſulphurated hidrogen gaſes which diſtend the inteſtines, and which are ſometimes extremely fetid, depend only upon a troubled digeſtion, upon a feebleneſs and inertneſs in the quality, or a diminution in the quantity of the gaſtric juice, upon an alteration in the bile, circumſtances which ſometimes concur, to leave in the alimentary maſs, the property of experiencing, inſtead of being converted into chyle, that fermentation peculiar to it, when the digeſtive liquors are not ſufficiently ſtrong, or not ſufficiently abundant to overpower and ſtop its production. Accordingly theſe caſes are accompanied with inflation of the abdomen, liquid acrid, fetid, diarrhoetic evacuations, and pains more or leſs acute.

8. The

ǀ. The phenomena and refults of digeftion fo far chemical, that they may be reduced the action of a folvent liquid, and to the fage of the diffolved aliment into capillary es; accordingly, it is one of the functions, apparatus of which is the leaft complicated, ich requires only very fimple organs, which eives but very little influence from, and es not require the concurrence of moft of other functions, which is conftantly and ily executed in animals of the leaft complicated organization, even in thofe that are titute of brain, of nerves, of heart, and of fels. It correfponds in fome meafure with fimplicity of the effects which take place the roots of plants. As being indifpenfable the fupport of the body, and the life of animals, it is exercifed with great facility; it efpes the action of many of the external caufes d organs, though it is not entirely exempt om it in man, on account of the energy and ifibility of a great number of nervous filaents which envelope or are contiguous to the mach.

Article V.

Of the Chemical Phenomena which take place in Secretion and Transpiration.

1. SECRETION, or the separation of several different liquids from the blood, in different organs of the bodies of animals, is perhaps the function least known, though at the same time it is the most generally diffused. It is found in the vegetables, in which, in fact, it is not uncommon to see the sap give rise to peculiar and different juices in their different parts, in which some have even carried the analogy so far as to admit glands, and a glandular system. Physiologists have successively imagined several theories for explaining the nature of secretion; they are all more or less hypothetical or improbable. For the greater part they suppose the different animal fluids to be contained ready formed in the blood, so that, according to this opinion, secretion consists merely in their separation by the glands. Its mechanism is supposed to be explained by the difference in the diameter, length, and convolutions of the vessels, and even by the varieties in the forms of the holes, with which the glandular system is supposed to be perforated: hence the expressions of strainers

ſtrainers and filtres ſo frequently uſed in phyſiology.

2. It can no longer be admitted that the blood is a mixture of all the animal liquids, that it is formed of ſaliva, of bile, of gaſtric juice, of urine, &c. ſince the moſt exact analyſis does not exhibit theſe liquids in it; and though all their compotent parts, as well as thoſe of the ſolids are in fact contained in it, they exiſt there without being combined as they are in each of theſe bodies. The blood is manifeſtly a homogeneous liquor, of one general nature, but diſpoſed to form all the animal matters, from the moſt tranſparent and leaſt compounded liquid, ſuch as the humour of the tranſpiration, to the hard and ſolid texture of the bones; it ſerves to conſtitute the ſaliva, the bile, the urine, as it ſerves to repair the muſcular fleſh, the membranes, the viſcera; but theſe different matters are not all contained ready formed in it, and the ſecretion muſt not be confounded with a ſeparation, or a filtration, as has been pretended.

3. As ſecretion cannot be conſidered as a mechanical operation, it muſt neceſſarily belong to the chemical phenomena; it muſt conſiſt in a change of nature which the blood undergoes in every glandular or ſecretory organ: accordingly we ſee that in the vicinity of each of theſe organs or of the organic ſyſtems, the ſanguineous veſſels are diſpoſed in ſuch a manner as to permit the liquid which they contain to aſſume a peculiar nature, and to produce

duce there the modifications required by its compofition. This is a preparatory difpofition, a fort of appropriation, which has not efcaped the notice of the moft ingenious phyfiologifts. In no part is this preparation more marked than in the vicinity of the liver or in the hepatic fyftem; I have noticed it fufficiently in the article concerning the bile and the fat.

4. Analogy, the light of which is frequently the only guide which we can yet follow in phyfiology, neceffarily induces us to believe that it muft be with all the fecretory organs, as with that of the bile; that the ftructure of the contiguous veffels or of thofe which penetrate them; that the number of thefe veffels itfelf, and the varied proportion of the red and the white ones; the difference of temperature which follows this proportion; in a word, all the circumftances of organifation which may influence the nature of the liquors of which they are the conductors, muft be fufficiently diverfified to produce, in the chemical elaboration of the humours, a difpofition to become faliva in the vicinity of the falivary glands, urine in the neighbourhood of the kidnies, &c. It may be conceived that this difpofition, dependent upon the vafcular apparatus, confifts efpecially in the retardation, the acceleration, the refrigeration, or the calefaction of the blood; the lofs or the abforption of fome principles; that it is to this that the different nature of the

blood

blood in the different regions of the body is to be attributed; that thus the aërated blood of the ſuperior parts ſeems diſpoſed to form light, frothy, &c. liquors; that the retarded and hidrogenated blood of the vena-porta already inclines towards the oily character of the bile, &c. &c.

5. As yet chemiſtry can furniſh only generalities upon this ſubject; and if it be underſtood that it belongs to the province of this ſcience to explain the cauſes and the products of the ſecretions, it is neceſſary that it ſhould be much farther advanced than it yet is, that it ſhould poſſeſs much more numerous experiments, much more exact inquiries, and many more animal analyſes than it yet does, in order to account for what paſſes in each particular ſpecies of ſecretion. It would be neceſſary to determine the temperature, the conſiſtence, and the nature of the cerebral blood, thoſe of the blood of the vena-porta, of the blood of the renal arteries, before the mechaniſm of the ſecretions which take place in the brain, in the liver, in the kidneys, can be comprehended. It will be no leſs neceſſary to acquire a better knowledge of the ſtructure of the glands, and to carry this part of anatomy beyond the point at which it has arrived, in order to inveſtigate what kind of influence the organization and the vaſcular texture exerciſe in the formation of the different fluids.

6. The

6. The fecretion, confidered in the way we have feen it in the four preceding numbers, greatly extends the limits of this function, fince we muft now define every change of nature in the blood, from whence the formation and feparation of a liquid or folid animal matter refults; whether this matter be deftined to remain in the interior of the organs, or whether it be to be rejected out of the body. Thus, befides the fecretion of the cerebral liquids, of the tears, of the nafal mucus, of the faliva, of the cerumen of the bronchic, gaftric and pancreatic juices, of the bile, of the urine, of the tranfpiratory humour, of the liquid of the interior cavities, of the fperm, and of the milk, we muft comprehend in this function the feparation and the depofition in the different organs of the matters which conftitute and repair them, of the albumen of the brain and nerves, of the gelatine of the membranes, of the fibrine of the mufcles, of the calcareous and gelatinous phofphate of the bones.

7. Though moft of thefe matters appear to be completely contained in the blood, yet their precipitation into the texture to which they belong, cannot be confidered as a fimple feparation; fince it is accompanied with a modification in the properties, in the nature, and the compofition of each of thefe matters; fince, as I have fhown in the chemical hiftory of each of them, the cerebral pulp is not exactly the fame albuminous matter as that of the ferum of the blood:

ood; the gelatine is not insulated in this quid as in the membranous texture; the musfcular fibrine has not a character abfolutely lentical with that which exifts in the fangui-eous fluid, and the phofphate of lime is not ffociated in the latter, with the gelatinous fub-ance which connects its particles in the ffeous texture. Hence it follows that fecre-ion always admits a change in its exercife, a ertain modification in the matter which is its roduct.

8. Amongft the different kinds of fecretion, here are few which have fo many direct relations with the chemical phenomena as the tranfpira-ion, on account of the air which receives the roduct, and of the contact of this fluid which s neceffary to its fupport. Though many re-earches ftill remain to be made upon this unction, upon the quantity and nature of the iquid which is difcharged from the fkin, upon the variations which it experiences, upon the kind of influence which it receives, from the interior of the animated body and the ftate of the organs, modern chemiftry has already found, in its no lefs exact than ingenious theories, refults capable of caufing a change in the opinions of the phyfiologifts and phyfi-cians refpecting the tranfpiration; they are chiefly to be afcribed to the experiments made in conjunction by Lavoifier and Citizen Se-guin. Thefe refults, indeed, relate only to the action of the air, which has hitherto been very little

little known, or very inaccurately ſtudied, and reſpecting which Sanctorius, Dodart, Keil, Bryan Robinſon, J. Rye, Gorter, Linings, and Hartman, notwithſtanding their numerous experiments, had only imperfect notions, or rather erroneous and falſe ideas.

9. The tranſpiration with reſpect to the cutaneous ſurface by which it takes place, is only the evaporation of a fluid, in a great meaſure aqueous, which is effected by virtue of the attraction exerciſed by the air upon this fluid. There is no tranſpiration without the contact of the air, which is its ſolvent. When it is regular and complete, it is at the ſame time inſenſible, as the fluid exhales diſſolved into vapour in the air, which is its neceſſary excipient. The ſweat is only the exceſs of the tranſpiration which the air cannot diſſolve. In a part of the ſkin, that is well covered and entirely defended againſt the contact of the air, there is no tranſpiration; but the liquid which the force of the heart propels to the extremities of the arteries, accumulates upon the ſkin in more or leſs abundant drops. The cloths oppoſe the vaporiſation of the inſenſible tranſpiration only partially, as they admit more or leſs of the acceſs of the air. The tranſpiratory humour may be collected in oil-ſkin bags covered with elaſtic-gum and applied to the two extremities of a limb in ſuch a manner as to intercept all communication with the air. Thus Citizen Seguin, in the experiments

periments which he made with Lavoifier, by
plying to himfelf a large filk bag, which clofe-
inveloped his whole body, and was folidly
ied round his mouth, found the means of
actly meafuring what he loft by the fkin, by
e weight of his body thus inclofed, compared
th that which it had in the air during the
ne fpace of time; and likewife of determin-
g the proportion of water which paffes off
'the lungs, as well as the relations of thefe
nctions with the ftate of the body.

10. It follows from this firft datum, that the
ier and hotter the air is, the more abundant
e infenfible tranfpiration muft be; that the
ore or lefs rapid motion of the air has a great
fluence upon this function, as upon an evapo-
tion; that air faturated with water, entirely
nihilates it, as though the body of the animal
as immerfed in water; that when the vital force
hich impels the humours from the centre to-
ards the circumference, and which is the pri-
ary caufe of the tranfpiration, is remarkably
minifhed, the air, fuppofing it to be very dry
nd of a great folvent power, may penetrate
to the pores of the fkin, and there diffolve the
umidity, which will occafion its deficcation,
takes place in bodies deprived of life, fkins,
nd woods, which dry at their furface, towards
hich the water is gradually carried as in ca-
llary tubes; that in the cafes where the vital
npulfe of the liquids is greater than the
lvent quality of the air, liquid drops or

 fweat,

ſweat, are formed upon the ſkin; that if the air found always on the elevation of its temperature wherewithal to ſaturate itſelf proportionably with water, it would never augment the inſenſible tranſpiration; that ſhould it go ſo far as to elevate itſelf above the human temperature; and at the ſame time ſaturate itſelf with water, it would rather depoſit drops of water upon the ſkin than diſſolve any.

11. All theſe conſiderations reſpecting the air, as a ſolvent of the matter of tranſpiration, lead us to ſeveral reſults different from thoſe which have hitherto been advanced upon this function: ſuch is that eſpecially of the cold air diſſolving water at the ſurface of the body, and favouring tranſpiration more than hot air. In fact, the air at 0 of temperature, and little charged with humidity, becomes heated, when it touches the ſkin, and by thirty two times a more powerful ſolvent of the water; ſo that at this temperature our bodies loſe more than in the hot ſeaſon. This augments greatly if the cold temperature of the air is joined with a conſiderable motion, or agitation which frequently renovates its maſs or ſolvent ſtratum. Accordingly, in cold and windy weather, the tranſpiration is, *ceteris paribus*, at its *maximum*, this is what then renders the ſkin dry, and as it were ſcaly; while in the ſummer, eſpecially when the air is humid, the ſkin is moiſt and the members ſwelled. Thus the

agitation

by exactly covering the ſkin, they almoſt completely interrupt the contact of the air, and prevent the ſolution of the water by this fluid, which they are not capable of abſorbing. On the ſame account, the uſe of woollen ſtuffs worn upon the ſkin is uſeful in ſome caſes, from the obſtacle which they oppoſe to the tranſpiration rather than from the augmentation of this excretion which has nevertheleſs been always attributed to it: this proves that the affections in which this kind of clothing is of ſervice do not proceed, as has been believed, from ſuppreſſed tranſpiration, but rather from exceſs or irregularity in this cutaneous evacuation. When we wiſh to favour the diſcharge of the tranſpiratory humour by the choice of clothes, we ought to take thoſe of linen or cotton ſtuffs, which having a great attraction for water, ſoon imbibe and become impregnated with it; they muſt be frequently changed in order in ſome ſort to replace the air, which does not immediately touch the ſkin.

15. The animals whoſe bodies are covered with hair muſt tranſpire much and ſweat little, becauſe the humour of the tranſpiration, diffuſed over the whole continuity of the hairs, and thus preſenting a ſurface perhaps a thouſand times greater than the ſkin, is much more quickly taken up and diſſolved by the air, than would be the caſe if it remained upon the ſurface of the latter. Beſides, the air inſinating itſelf between the hair, becomes more heated than

by

by the mere contact of the skin, on account of the larger surface which it touches, and thus becoming a better solvent of water, it must take up a much larger quantity than from animals with a naked skin. It is undoubtedly owing to this circumstance that several of the mammalia have been said never to sweat.

There are still many curious inquires to make relative to this subject, among the various classes and genera of animals.

Article VI.

Of the Chemical Phenomena which take place in Nutrition.

1. NUTRITION presents great difficulties to the physiologist. It is not only very difficult to determine how a primitive homogeneous liquid, the blood, contains all the different materials proper for constituting the different parts of the body; but it is still more so to know how the various liquids which emanate from it are converted into solid matter which incessantly attaching themselves to the organized textures of which the viscera and the parts of the body are composed, perpetually renovate the mass, and thus repair the losses which are occasioned by the vital movements.

2. The problem of nutrition is composed of two other problems equally important and difficult to be resolved. The object of the first is

is to determine how the organs or folid parts augment in extent and weight during a certain period of the life of animals confecrated to their growth; and why this growth ftops at a certain period; the fecond relates to what takes place after growth, and in maintaining the organs in the fame ftate of extent, of form, of weight, and efpecially of vital powers, or to the uninterupted reparation of the parts which are deftroyed by the action itfelf which they exert.

3. In order to explain the phenomenon of growth, it has been fuppofed, that the organs were originally formed of parts fufceptible of great extenfion, of cells or laminæ united or folded together, which receiving into their pores or at their furfaces the nourifhment which is applied to them by the work of nutrition, become elongated, extended, and unfolded to a determinate magnitude according to the fpecies of the animal, and the developement, or of which extenfion does not ceafe till the period when they can no longer yield to the elongation; it was neceffary alfo in this theory, to fuppofe a determinate primitive form in the organs, and to confider thefe as kinds of moulds upon which the animal matter applies itfelf at all points.

4. What belongs to the province of chemiftry in this firft part of the problem of nutrition, is the rapid and eafy formation of all the different compounds which are deftined to enlarge each of the organs of the body: and firft, the very

very confiderable digeftive power; the quantity and folvent energy of the gaftric juice, which producing a more frequent and greater appetite or hunger, requires a more ample accumulation of aliments in the ftomach; a more rapid effect of the hematofis by the more frequent refpiration and circulation; a more fpeedy renovation of the blood, as well as a more eafy and quick feparation of the different materials, which conftitute it in the organic regions to which it gives life; a more powerful attraction of each texture for the matter appropriate to it, and which is conveyed to it in greater abundance and with greater celerity than in the other periods of life; finally, a more accelerated and more powerful concrefcibility in the nutritious humour, accompanied however with an energetic abforbent power in the whole fyftem of white veffels.

5. As to the common or fimple maintenance of the organs after the end of growth and till that of life, it is performed by the fame mechanifm; it admits the fame chemical phenomena; it fuppofes the uninterrupted confequence of the affimilating power, and only fhews it diminifhed in its energy, and gradually lofing, till old age, a part of its force. In order to account for the tranfition of the nutrient liquids into the folid and organic ftate, phyfiologifts have admitted with the ancients, a plaftic power, or a general concrefcible property, which has appeared to them fufficient for the explanation

lanation of this phenomenon. The modern mifts, who have advanced a little farther n had been done before them in feeking into caufe and the nature of this concrefcibility, ow now that it proceeds from the combina- n of oxigen, and that it is on this account t the animal liquors have fo much difpofi- n to abforb this principle.

. Though nothing is yet known refpecting the rticular nutrition of each organ, or refpect- g the influence exerted upon it, both by the ftem which furrounds it and that of the or- nic texture itfelf, we fee that this function, nfidered generally, fuppofes a complete fimilation, an entire change of primitive imentary matter into each particular or- nic fubftance; that this affimilation, com- enced in digeftion, continued in refpiration, moft completed in the different ftages of the cir- lation, and entirely terminated at its entrance to each organ to be nourifhed, principally nfifts in the lofs of the carbon and hidrogen, the augmentation of the azote, and in a fort transmutation which has hitherto been named imalization. Notwithftanding the varied tures which the textures of the different gans appear to prefent, we may clafs them in- three or four matters, as I have feveral times id; namely, the gelatin, which forms the fe of the membranous textures; the albu- en, which conftitutes that of the brain, of the erves, and of the parenchyma of the vifcera; the fibrine

fibrine which composes the muscular fibres, and the gelatiniferous phosphate of lime, which belongs to the bones.

ARTICLE VII.

Of the Chemimal Phenomena which take place in Irritability.

1. NEARLY forty years have elapsed since the physiologists first perceived some relations between the irritable force of the muscular fibres, and the chemical powers; because since the experiments of Haller, they have observed that the acrids, the acids, the alkalies, the metallic salts, have the power of exciting, by the slightest contact, the contraction of these fibres; and they have even derived from this effect the appellation of irritability, which has been given to this function, which, whilst it presents the most strongly marked characters of animated bodies, has appeared involved, with respect to its cause and effects in insurmountable difficulties. The immediate conclusion which had been drawn from the action of acrid and irritating substances upon the contractile muscular property, was formerly confined to the supposition, that the will and vital power conveyed into the muscles, in

n order to cause their motion, a stimulus ca-
able of exciting their contraction, as was done
y any extraneous acrid body, with which they
vere touched.

2. The discovery of Galvani, and the labours
f many modern physiologists, especially of Mr.
Humboldt, upon this discovery, have shewn
hat the chemical properties have great influ-
nce upon the exercise of the irritable power
f the muscles, and that the action which takes
lace during their contraction between the
ervous pulp, and the muscular fibre, has
ential relations with the phenomena that
elong to the province of chemistry. Different
etals, the one touching a nerve, and the
ther a muscle, or attached on each side to these
bres, by the name of *armatures*, and a com-
unication being afterwards by means of a
etallic branch, excite a more or less violent
nvulsion in the muscles of an animal recently
lled. The mere immediate contact of a mus-
e and a nerve, both laid bare, produces the
me effect. A similar one is made to take place
on living animals; frequently these experi-
ents, applied to different parts of the mouth
d of the face, or of the intestinal tube, give
se to sensations of smell, of taste, of pain, of
at, of vision, and even to augmented secre-
ons or evacuations. The modern works upon
alvanism, or the metallic irritation, are replete
ith facts that prove these assertions.

3. Many

3. Many philofophers believe that the phenomena of galvanifm depend upon electricity, and proceed from the electric fluid; this is efpecially the opinion of the celebrated Profeffor Volta; however, Mr. Humboldt has found bodies which, without being conductors of electricity, are fuch of galvanifm. But, even fuppofing that ulterior refearches might convince all philofophers that thefe two phenomena proceed from the fame caufe, galvanifm would neverthelefs be referable to a chemical effect, as there manifeftly exifts fuch a one in electricity. In order to conceive this connection between the galvanic phenomenon, and thofe which depend upon chemical powers, we muft admit vaporous atmofpheres, more or lefs thin at the furfaces of all bodies, and efpecially thofe of metals; the fmell which they exhale to a certain diftance, the oxidation frequently very prompt which they undergo, when they are placed one upon the other under water, evidently prove the exiftence of thefe atmofpheres, and the chemical action to which they are fubject.

4. With this firft datum, it is impoffible to deny a chemical effect in the galvanic phenomenon, and confequently in the mufcular contraction, or the exercife of the irritability of the mufcles. Even the manner in which this irritability, or fufceptibility of the mufcles to the galvanic irritation, is weakened or augmented in which it is checked, or its duration prolonged, by the aid of chemical powers, or different

different re-agents, farther proves its intimate relation with the laws of chemiſtry; but of what nature is the chemical act, the kind of combination or of decompoſition which takes place in the muſcle or in the nerve, or in both at once, at the moment when the muſcular contraction is performed; and how are the ſhortening and the ſwelling of the fibre its conſequence? All this is ſtill a problem, which can only be ſolved in imagination, ſince experiment has not yet been able to teach us any thing reſpecting this ſubject. It only appears ſufficiently certain that this effect of the decompoſing or recompoſing attractions does not ſenſibly change the nature of the muſcle and of the nerve, and that the cauſe which gives riſe to this effect, is changeable, moveable, and in ſome ſort acceſſory to the muſcular fibre, ſince the effect diminiſhes or augments the activity, promptitude, and force; ſince the fibre experiences fatigue under it, and requires a reſtoration which is procured to it by repoſe.

5. There is reaſon to believe, that it is at the point of contact between the nerve and the muſcular fibre that this takes place, that it is between two ſubſtances exiſting in theſe two organic textures that it is exerciſed; that the nerve brings, by the action of the will or any ſtimulus, the matter which gives riſe to it; that this is what has been called the nervous fluid, or the animal ſpirits; that the contraction conſiſts in this re-action itſelf between the two textures; that the chemical action having taken place, and the ſtate

ſtate of the bodies changing by this chemical effect, are the cauſes which renders it ſo rapid, and which ſo ſoon bring about its ceſſation; as well as the relaxation of the fibres which is its conſequence; that it is on this account that the voluntary effort of a continued contraction requires a conſiderable force, of which laſſitude and pain are the neceſſary conſequences. It is alſo evident, according to this theory, that all the movements in the animal economy, dependent upon muſcular irritability muſt be intermittent, or marked by ſucceſſive periods of activity and repoſe; that the heart, being the moſt energetic, the moſt vigorous, and the moſt independent of all the muſcles, muſt have a more abundant and more frequently renewed ſource of irritability and motion than all the others, as appears from the conſiderable quantity of blood which it receives, and of nerves which are diſpered through its texture.

Article VIII.

Of the Chemical Phenomena which take place in Senſibility.

1. IRRITABILITY preſents to the philoſopher but very few applications of chemiſtry, though it may be perceived that its cauſe and its effects are ſubject to the chemical attractions,

or at leaſt are much accompanied by them, as appears from the galvanic experiments. Senſibility is ſtill more abſtruſe in its mechaniſm, and in its ſource. The theory of this function is covered with the moſt impenetrable veil; it is a myſtery, the depth of which no human mind has yet been enabled to fathom. The moſt minute diſſections, the moſt multiplied experiments, phenomena the beſt deſcribed, and the beſt compared by phyſicians, who have ſo many opportunities for obſerving all the circumſtances which ſenſibility, weakened or exalted, modified or altered by diſeaſes, can preſent, have as yet hardly aſcertained any thing reſpecting this function.

2. It is alſo this part of phyſiology which has given the moſt occaſion to conjectures; in which the imagination has the moſt gone aſtray. The mechaniſm of the ſenſations, the relation of the nerves with the object felt at the ſurface of the body, and with the centre in which the ſenſation is united, are as obſcure as they have always been, notwithſtanding all the facts which have been collected for many centuries paſt. What are called the internal ſenſes: Thoſe functions which are generally referred to the brain, ſuch as the memory and the imagination, are ſtill more difficult to comprehend, than the external ſenſations. Pleaſure and pain, deſire, the will, all the paſſions which have their ſeat in the cerebral labyrinth, and their miniſters in the nervous filaments, diſtributed throughout

throughout all the organs of fenfation and motion, are fo many problems, whofe folution is the moft remote from the refults that may be expected from the progrefs of the fciences. It is befides on account of the immenfe chafm which the ftudy of the mechanifm of this function leaves in animal phyfiology, that we are led to confider the fcience of the organized and living bodies, as much above the common phyfical fciences; or as a fcience entirely different, and of a quite peculiar nature.

3. As it is impoffible that thefe functions fhould be exercifed by the intervention of the folids alone, or that the fluids fhould not be the moft active of the inftruments which nature has appropriated to their exercife, in conformity with the fictions of the animal fpirits, the vital fpirits, the nervous fluid, it was believed, from the clofe analogy with the known data of phyfics, that they ought to be afcribed to the electric, the magnetic fluid. Of late, recourfe has been had to a particular fluid, called the galvanic, from the difcovery of the Italian phyfician, of whom I have juft fpoken, and becaufe remarkable differences have been obferved between the progrefs of electricity, and that of galvanifm. It muft, however, be allowed, notwithftanding thefe more ingenious approximations, that no fatisfactory explanation has yet been found of the mechanifm itfelf, of the function of the brain and of the nerves, particularly in their

relation

elation to the internal senses, especially of what ppertains to the internal senses.

4. M. Humboldt believed he might hazard conjecture respecting the chemical funcion of the brain, both with respect to the luid which is conveyed into it to nourish and vivify it, and to its action relative to sensibility and irritability. He imagined that the blood conveyed into the cranium by the carotoid and vertebral arteries, transmitted immeliately from the left cavities of the heart, after having been renovated in the lungs, arrived in he brain, charged with a large quantity of oxigen; that a part of it was speedily deposited n the pulp of this viscus, and that it was to his principle, thus accumulated or deposited, hat the cerebral substance might owe its principal properties.

5. But though this notion seems to accord with what I have said elsewhere, respecting the luminous nature, the concrete and manifestly highly oxigenated state of the albuminous cerebral mass, yet how far distant is this first lea from a satisfactory explanation of the functions of the brain and nerves? How can we admit oxigen as a fluid sufficiently rare, light and rapid in its motion, to be substituted in place of the electric, magnetic, and galvanic fluid? How conceive that this liquid or gazeous body can pass through a pulpy texture, through full and solid ligaments, in which it has hitherto been impossible to discover the least trace of canal

 or

or cavity? Can it be ſuppoſed with probability, that the cerebral and nervous medulla has the property of ſucceſſively ſaturating itſelf with oxigen, and abſorbing it from its origin in the ſame proportion as it eſcapes, or is exhauſted at its ſentient or moving extremity, ſo that the integrity of the ſenſitive organ ſhould conſiſt in this conſtant ſtate, in this permanent equilibrium of the oxigenation of this organ, inceſſantly nouriſhed by the oxigenated blood which arrives in it immediately as it iſſues from the pulmonary apparatus?

6. Let us admit that nothing is as yet more incomprehenſible, that no myſtery is more impenetrable, than what appertains to the functions of the brain and nerves, in the exerciſe of ſenſibility and mobility, and eſpecially in that of the internal ſenſes. Let us acknowledge that no datum yet leads to the ſolution of this ſublime problem, ſo remote in its eſſence, as well as in its cauſe, from all the other parts of natural philoſophy. Well convinced that all that has hitherto been ſaid reſpecting this ſubject, belongs only to the reveries or conjectures of the imagination, we may nevertheleſs maintain, that though as yet not very ſucceſsful, the efforts of modern chemiſtry ſeem to deviate leſs from the truth, than the mechanical or phyſical explanations that have heretofore been given, and that if it may be permitted to the human mind to hope for ſome inſight into these functions, hitherto ſo ſuperior to its comprehenſion,

enſion, it will receive greater aid in theſe ſearches from the chemical powers, than from he different means that have been employed or obtaining it.

Article IX.

Of the Chemical Phenomena that take place in Generation.

1. THOUGH the phenomenon of generation inveloped in almoſt the ſame obſcurity as at of ſenſibility, though this reparative and nſervative function of the human ſpecies has ways appeared to philoſophers to be covered ith a veil of myſtery, the experiments of the eſent age, have, however, begun to draw ide this veil, or at leaſt to diminiſh the darkſs in which it is involved. If its profundity s not yet been fathomed, prejudices which eir antiquity had rendered reſpectable have, at ſt, been deſtroyed, and ſome principal facts ſcovered, the application of which, to the enomena already known, has become a new urce of prolific truths.

2. We have ſhown in the hiſtory of the ſpertic liquor, and in that of the liquor of the nios, that chemiſtry is not entirely uſeleſs in reſearches relative to generation. To have

aſcertained with exactneſs the nature of the fecundating liquor which gives the firſt movement of life to the organic rudiments in the maternal ovum, is to have made a ſtep farther in the hiſtory of this function. It is true, this knowledge has not yet thrown any light upon the mechaniſm of fecundation, neither do we ſee in the mucilage, or in the phoſphate of lime, and ſoda of the ſperm, the ſource, or the cauſe of this wonderful property which communicates the vital movement. It is not leſs certain that we ſee no relation between the moſt accurate analyſis of the eggs or of the ſperm, and the extraordinary, and as it were, inexhauſtible power of the latter, which uniformly communicates its fecundating property, to ſeveral thouſand times its weight of water.

3. But let us not conclude from the hitherto inſurmounted difficulties which the hiſtory of generation preſents, that they muſt ever remain inſurmountable. Let us not loſe our courage, nor relinquiſh our hopes; let us conſider, that almoſt nothing has yet been done in compariſon with what remains to be done; that only one chemiſt has yet examined the ſeminal liquor of a ſingle ſpecies; that this examination muſt be purſued in the different claſſes of animals, eſpecially in the moſt prolific, compared with thoſe that are leaſt ſo. Let us hope that at ſome future period, an unexpected diſcovery may point out a road hitherto unknown to phyſiology, and let us not relinquiſh the idea, that

that chemical experiments applied to matters peculiar to the fœtus, and hitherto completely unknown, may lead to fome new truth, the exiftence of which, no mode of phyfiological refearch has yet led us to fufpect.

ARTICLE X.

Of the Chemical Phenomena which take place in Offification.

1. OSSIFICATION, or the maintenance and formation of the bones, is the function which has received the moft light from the knowledge and difcoveries of chemiftry. The offeous texture, compofed of a thickened gelatinous mucilage which forms its organic parenchyma, and of phofphate of lime depofited in the areolæ of the former, either in the form of grains, or of fibrous filaments, or in the ftate of imbricated laminæ, has been well afcertained, only by the labours of the modern chemifts. The action of water, and of the alkaline or faline leys, upon the gelatinous body which they diffolve; that of the acids, which, by carrying off the phofphate of lime before the gelatin, foften the bones, and render them at the fame time tranfparent and cartilaginous; calcination, which, by decompofing and deftroying the gelatinous

fubftance, infulates the phofphate of lime, if it has continued for a fufficient length of time; the lixiviation of thefe bones calcined to whitenefs, which, by feparating fome portions of muriate and carbonate of foda, contributes ftill more to purify the phofphate of lime, of which their bafe is compofed: thefe different analytical operations have left nothing more to be defired, refpecting the nature of thefe folid organs.

2. The compofition of the bones, once well determined, it was no longer difficult to comprehend the mechanifm of their formation, which is called *ofteogeny*. The bones of the fœtus, immediately after it has left the egg, or the womb, are a kind of foft and tranfparent membranes, in the duplicature of which, the phofphate of lime depofits itfelf, and fills the areolæ. This earthy falt is not precipitated alone and pure, as is proved by the calculous concretions of the bladder, and the other regions, in which we find the infoluble phofphate combined with a gelatinous matter. The rapid formation of the bones in the firft periods of life is explained by the fuperabundance of the phofphate of lime, owing either to the nourifhment, or to the non-evacuation of this falt, of which the human urine is deftitute at this age.

3. There is no doubt that the calcareous phofphate is conveyed into the bones by the fanguineous liquid, which penetrates into them by veffels fufficiently numerous, to render their colour reddifh in newly born animals, and in the

the analyſis of which we find this earthy ſalt. The chyle inceſſantly pours the oſſeous materials into the blood, ſince the phoſphate of lime exiſts in all the aliments, and eſpecially in the farinaceous vegetables, or in the animal matters. The examination of the farina of wheat, has proved to Citizen Vauquelin and myſelf, that man takes every day between three or four grammes of calcareous phoſphate, in the quantity of bread which forms the moſt abundant part of his nouriſhment, and that this ſalt is generally one of the moſt conſtant, and moſt common inſoluble and fixed matters, in the inſipid, and as it were, earthy reſidues of the vegetable and animal ſubſtances.

4. When the primitive membranous parenchyma of the bones of the human fœtus, is ſufficiently charged by the depoſition of the gelatinous calcareous phoſphate; when the firſt work of oſſification is ſufficiently advanced, for the bones to be well formed, ſolid, and capable of reſiſting the action of the muſcles, ſo as not to be bent by their different motions, the exceſs of inſoluble phoſphate is conveyed into ſome particular regions; the teeth become hard, elongated, and protruded from their alveolæ; the urine evacuates the ſuperabundance of this ſalt, which it did not contain previous to this period. In the mammalia, in which this liquid contains little or no phoſphate, it depoſits itſelf in the hair which covers the body; in the horny ſubſtance which terminates

minates their extremities; in the corneous appendages with which their heads are provided, or elſe it paſſes off by the ſkin, with their tranſpiratory humour, and is every where accompanied with the gelatinous ſubſtance, with which it is conſtantly found mixed in the animal body.

5. If by any cauſe, the natural evacuant of the redundance of calcareous phoſphate, does not employ itſelf in the proper proportion, the ſubſtance is diſpoſed to concretion, and is conveyed into a multitude of places where it is depoſited: this is what happens in advanced age, when the bones, ſurcharged with earthy phoſphate, become brittle, when this ſalt is depoſited in the tendons, in the vaſcular ſides, at firſt towards the extremities, the motions of which become ſlow and difficult, afterwards, and gradually, from theſe extremities towards the centre, and even in the large veſſels of the baſe of the heart. Thus, the ſeſamoid bones are firſt formed, towards the extremities of the tendons of the fingers, of the ligaments, of the capſular membranes, or towards the articulations, and afterwards the oſſeous concretions which take the place of the ſoft and membranous ſides of the veins and arteries. Thus, in the prolonged exiſtence of man, and of animals, gradually originates the cauſe of natural death from old age, of which the ſlowneſs in the motions is the neceſſary ſource, and of which the ſuperabundance and deviation of the calcareous phoſphate is a preliminary ſymptom.

ARTICLE

ARTICLE XI.

Of the Variations which take place in the Chemical Phenomena of Life, according to the different Structure and Nature of the Animals.

1. I HAVE hitherto indicated the chemical phenomena which take place in the animal body, only in their greateſt generality, and have conſidered them more eſpecially in man, as the moſt perfect type of animality. Though there is a great analogy, in a chemical point of view, between the effects which take place in all animals; and though what has been ſtated in the ten preceding articles, may ſerve to explain what takes place in the different orders of beings which enjoy animal life, it is neceſſary that I ſhould here point out the principal varieties, which theſe chemical phenomena exhibit, or at leaſt the moſt ſtriking differences that riſe from the varied ſtructure, and different modes of vitality of animals.

2. The variations in the ſtructure of the principal organs of life, eſpecially in thoſe of reſpiration and circulation, produce in animals, modes of exiſtence and of action, more or leſs different, as appears from anatomical and phyſilogical

physiological researches. Those which respire air by the lungs or by stigmata, and those which only introduce or receive water into their respiratory organs, must present, and in fact do present very different results in the exercise of this function itself, in the products which it gives, and consequently in many of the other phenomena of life. As the effect of respiration is in general a very manifest chemical action, this action must be different according to the mode itself, in which respiration is performed.

3. From this source, especially proceed the most remarkable differences of the chemical phenomena, which exist in animals; the air introduced into the respiratory organ, of whatever nature it may be, serves to absorb the superabundant hidrogen, and carbon, as well as to precipitate oxigen into the humours; from these two actions result the animalization, the vivification, the equilibrium of composition of the humours, and consequently, as we have seen above, the muscular irritation, motion, life, assimilation, and nutrition. What differences must arise from variations of this primitive effect, in the different orders of animals, from the birds which absorb the most air and oxigen, which have the most strength, activity, and life, in proportion to their mass, to the cartilaginous fishes, which, admitting only muddy and slightly aërated water into their fixed gills, have scarcely any means of evacuating the hidrogen and carbon? Is it not evident, that

from this difference proceeds the exceſſive mobility of the firſt of theſe animals, and the ſlowneſs of motion, and ſoft oily ſtate of the fleſh of the ſecond?

4. How many other differences might be deduced from this primitive ſource, were all the varieties preſented by the reſpiratory organ, and the influence of the air and the oxigen reſpired, profoundly examined in all the orders of animals. How many reſults, prolific with conſequences no leſs new than uſeful, would be afforded by a well made compariſon, between all animals, relative to the quantity and the nature of the air which they reſpire, to the ſtate of this fluid at its exit from their organs, and to the proportion of water and carbonic acid which they form. It is already known that they all attract the air in the ſame manner, that they all form carbonic acid in it, and abſorb oxigen from it; but from a compariſon of the proportion of air which they require; of the quantity of acid which they yield, relatively to their weight, and the ſurface of their reſpiratory organ; with their irritable power, their muſcular ſtrength, their digeſtive energy, and eſpecially with their inſenſible tranſpiration, how many important data for animal phyſiology might be collected? I can here only ſketch a mere outline, of all the reſources which chemiſtry promiſes; I only wiſh to ſhow the poſſibility of acquiring a large ſtock of valuable knowledge, by experiments

riments which it is now in the power of the art to bring to perfection.

5. What I have juft announced with refpect to the diverfity of the chemical effects by the air in refpiration, relatively to the difference of ftructure in the animals, may be applied to all the other functions. Even were it not confirmed by obfervation, it would be proved *a priori*, by the confideration of the neceffary relations eftablifhed by nature between thefe two primordial functions, this principle of life, the circulation, and the refpiration, and all the other functions which are in many refpects only their neceffary confequences. In this manner Lavoifier and Seguin have been conducted in their ingenious refearches from the experiments upon refpiration, to thofe upon the functions of the fkin and ftomach. In fact, digeftion, which renovates inceffantly the mafs of the blood, muft correfpond with the rapidity of the motion of this liquid, and the lofs which it fuftained in the lungs; the tranfpiration which evaporates a large quantity of water, and which, by this evaporation itfelf, carries off a portion of the caloric, abforbed by the pulmonary blood, muft follow the pulmonary and circulatory motions, in the products whofe equilibrium it is deftined to eftablifh and maintain. All the fecretions correfpond in the fame manner with the laws of thefe *primæ mobilia* of life; the extent and force of the movements, the weaknefs or energy

of the fenfes, the rapidity or flownefs of nutrition, even the duration of life, are fubject to their direct influence.

6. If to this notion, which is already rendered a ftriking truth, by the reafoning upon which it is founded we join the obfervation of what takes place in the different orders of animals compared with each other, under the new relation of the chemical phenomena, which they prefent in the exercife of their life, we fhall fee that it confirms what has juft been fet forth. Thus we find that the reptiles and fifhes, which refpire but little, or which do not refpire air, which have not blood of a temperature conftantly more elevated than that of the medium which they inhabit, which abforb but very little oxigen, have at the fame time very little or no refpiration, and fuffer no lofs by their fkin, which is covered with folid fcales clofe to each other. We fhall find them poffeffed of little fenfibility, and an irritability which is tenacious in its duration, only becaufe it is weak and little exhaufted by ftimulants. We at the fame time find in them foft and glairy flefh, abundance of oil and liquid fat, a very flow growth, a prolongation of life on account of its little activity, fcanty, rare, or frequently interrupted fecretions, a tendency to repofe or fattening, a flow reftoration, &c.

7. This obfervation relative to the chemical nature of the organs, prefents as its refult, two

two general claffes of animals, proceeding originally from the contact and abforption of the air being very confiderable in the one, and very feeble in the other.

The firft, which are conftantly immerfed in the atmofphere, which inceffantly renovate the air around them by very rapid changes of pofition, have highly oxigenated, highly concrefcible, much heated, and very irritating humours; folid, moveable, irritable hot organs; they are very active in their functions, and require to be perpetually renovated: man, the mammalia, birds, and many infects, are in this order.

The fecond, concealed in the earth, or in fubterraneous cavities; or in the midft of the waters; capable of living without air, or without a renovation of it; having frequently an intermittent refpiration; remarkable at the fame time by the flownefs of all their motions, and by the little elevation of their temperature, as well as by the paucity of their evacuations, prefent, in their liquids, compounds, furcharged with hidrogen and azote, and but little oxigenated in comparifon with the preceding. The reptiles, ferpents, fifhes; and many of the teftacea, belong to this clafs.

8. Every thing muft vary, and actually does vary in thefe two orders of animals, as is proved by their anatomical infpection, and their chemical analyfis, and by the ftudy of their functions, or their phyfiology. Each of the phenomena which they prefent, depending upon

this

is first difference of nature, and of compo-
ion, have, in the exercise of their life, varieties
pendent upon the same cause. To this dif-
ence we must particularly refer the glairy
mours, the viscous and insipid mucilages,
iich are so frequently and so abundantly dis-
arged from the bodies of cold-blooded ani-
ls, and which we do not see produced by
ose animals which respire much air; from the
ne source arise both the abundant nourish-
ent, the frequently renewed hunger of the
:ter, and the little aliment and possibility of
isting without it for a long time, which is
served in the former. On account of the same
imitive difference, the bones also do not
quire the same hardness in the little-oxigenated
imals,— as they do in those which absorb
uch air. The skeleton of the first is either
rtilaginous or excessively porous; less phos-
ate of lime, and much gelatinous matter is
und in them; there are also both without and
ithin the bodies of cold-blooded animals,
any particular oily substances which are not
und in the hot-blooded animals.

9. I shall not pursue farther, the differences
hich exist between the chemical phenomena,
f the different orders of animals; I only
ished to present a simple indication of these
ifferences, in order to show, that they corres-
ond with those of the structure, and that these
tablishing different relations, between the liv-
ig animals, and themedia which they inhabit,
ariations must ensue in the products which are
in

in many refpects their refults. It may be judged from this fingle idea, how many difcoveries remain to be made in this line of chemical refearches, and what improvements the fcience of animal phyfics may hope from it.

Article XII.

Of the Chemical Phenomena which take place in Difeafes.

1. IT has long been admitted by phyficians, that chemical phenomena exift in the difeafes which attack men and animals; that their humours undergo changes of nature more or lefs marked, and even that thefe changes are frequently the true caufes of the morbid affections. Since the fyftems of the laft century, which have retarded the progrefs of the art, by the injury which they have done it, and in which medical chemifts were too hafty and too bold, and confequently formed dangerous applications of their opinions to the nature of difeafes; wifer phyfiologifts, confining the chemical theory to juft bounds, have rendered great fervice to medicine, and have perceived in how far chemiftry might be of advantage, and in how far it might be detrimental to it.

2. Thus

2. Thus Boerhaave, one of the moſt enlightened men in all the ſciences applicable to the art of healing, has pointed out diſeaſes proceeding from a glutinous humour, and others owing to a ſpontaneous acidity; thus he has directed the treatment of a great number of affections, according to the chemical characters of the alteration of which the humours and ſolids of the human body are ſuſceptible, by comparing them with the oppoſite properties of the remedies. Thus, alſo, he has given precepts of great utility reſpecting the treatment of poiſons and acrid bodies. Well acquainted with the miſchief which had been done by means of chemiſtry before his time, and with the abuſes to which it had given riſe with reſpect to the employment of curative means, he was enabled to ſteer clear of the rock upon which ſo many others had ſtruck before him, and uſefully to employ thoſe profitable applications which the one of theſe ſciences conſtantly preſents to the other.

3. Chemiſtry, advanced much farther ſince his time, enriched with a multitude of important diſcoveries, and proceeding with a much more ſteady courſe in her new theory, has reſolved, during the laſt twenty years, many problems relative to the pathological ſtate of the liquids and ſolids. It is now known that inflammation does not conſiſt in a concretion of the blood, but that it is accompanied with a concreſcible diſpoſition in the albumen and fibrine, which manifeſtly depends upon the greater degree

 of

6. The theory which I have juſt enunciated, embraces in its generality a very conſiderable number of diſeaſes; but it may be applied to all, or extended ſufficiently by analogies to form an entire doctrine of pathology. Can we eſtabliſh upon this firſt notion, however well-founded it may appear, for determining two claſſes of morbid affections, an entire ſyſtem of noſology, or rather of pathologic ethiology? Ought we, with ſome modern authors, to claſſify all diſeaſes into hidrogenated, oxigenated, carbonated, azoted, according to the exceſs of one or other of theſe four principles? I do not think chemical ſcience is ſufficiently advanced to authorize this mode of claſſification, and its adoption as the baſe of medical theory. We have neither obſervations ſufficiently numerous, nor experiments ſufficiently deciſive to admit theſe notions as demonſtrative truths. I even fear, that by theſe premature applications, we may compromiſe the fate of a ſcience, which can only be of great utility when it is applied to the art of healing, with that prudence and reſerve which the latter requires. Enthuſiaſm, and improper indulgence of the imagination, are no leſs detrimental to its progreſs, than the prejudices and oppoſition with which ſome perſons reſiſt the chemical diſcoveries which may really tend to its improvement.

7. It is by continuing to obſerve the effects and the ſymptoms of ſeparate diſeaſes, by neg-

in the motions; this ſtate exiſts in hœmophyſis, and in the beginnings of phthiſis pulmonalis; it is obſerved in many diſeaſes. The whole ſyſtem of the organs of the body is ſuppoſed to be equally ſuper-oxigenated in this diſpoſition. It is chiefly deſtroyed by the reſpiration of air, mixed with azote or carbonic acid gas. Veneſection, aqueous drinks, ſtrict diet, light aliment, are alſo very uſeful in it. The hidrogenated ſulphurets form its ſpecific remedy.

5. The caſes in which there is a deficiency of oxigen, and in which hidrogen is admitted to be predominant, announce themſelves by ſymptoms entirely the reverſe of the former. The face has little colour; the cheeks and lips are of a livid and violet caſt; the teeth dingy, and covered with tartar; the breath fetid; the motions ſlow and difficult. There is a general ſenſation of debility, which ſometimes goes ſo far as to induce fainting; the pulſe is ſmall and low, the reſpiration difficult; the pulſations of the heart are irregular. This is the ſtate of the body in the ſcurvy, in ſeveral chronical diſeaſes; it is in ſome ſort a commencement, or firſt degree of aſphyxia. Pure air, the acids, the oxidated metals, the acrid, bitter, tonic vegetables, are the remedies for this diſpoſition. The oxigenated muriatic acid, the oxigenated muriate of pot-aſh, the reſpiration of oxigen gas, or of air, with an addition of oxigen gas, are its ſpecifics.

6. The

phates; and in the alkaline carbonate for the calcareous oxalate, may be employed with leſs uncertainty and better hopes than had been poſſible before our time. It will not be denied that the virulent and contagious diſeaſes may become better known by chemical reſearches, both with reſpect to the nature of the virus, and to its deſtruction. The poiſons afford ſtill greater ſcope for chemical reſearches, and every one muſt acknowledge the advantage which this ſcience affords in the knowledge and choice of counter-poiſons. Let chemiſts continue to put nature to the queſtion by the ſame means; let them purſue with ardour the career which is open to them; let them ſuffer no opportunity to eſcape for extending the applications of chemiſtry to the knowledge of diſeaſes, not endeavouring to divine cauſes, but poſitively to aſcertain effects; and the art of healing will gradually arrive at a degree of perfection and certainty which it has never yet approached.

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A
GENERAL SYSTEM
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&c. &c.

A GENERAL SYSTEM OF CHEMICAL KNOWLEDGE; AND ITS APPLICATION TO THE PHENOMENA OF NATURE AND ART.

BY A. F. FOURCROY,
Of the National Institute of France, Counsellor of State, Professor of Chemistry at various Public Establishments, Member of many Academies, &c.

IN ELEVEN VOLUMES.

TOGETHER WITH A SET OF SYNOPTIC TABLES IN LARGE FOLIO.

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